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Forthcoming Events.

MARCH 7.

Institute of Metals (Sheffield Local Section):—Ordinary meeting at Sheffield. "Some Aspects of Alloy Plating," Paper by S. Field, A.R.C.Sc.

Society of Chemical Industry (South Wales Section):—Ordinary meeting at Cardiff. "Metal Colouring," Paper by E. A. Rudge, B.Sc.

MARCH 8.

Institute of British Foundrymen (West Riding of Yorkshire Branch):—Ordinary meeting at Keighley.

Institute of British Foundrymen (Scottish Branch):—Ordinary meeting at Glasgow. "Refractory Thoughts in a Refractory Mood," Paper by H. Winterton.

MARCH 10.

Institute of Metals (Scottish Local Branch).—Annual general meeting.

MARCH 12.

Institute of British Foundrymen (Coventry Branch).—Ordinary meeting at Coventry. "Physical Tests on Cast Iron," Paper by John Shaw.

MARCH 13.

Birmingham Metallurgical Society.—Ordinary meeting at Birmingham. "Corrosion of non-Ferrous Metals," Paper by Dr. G. D. Bengough.

MARCH 14.

Manchester Association of Engineers.—Ordinary meeting at Manchester. "Modern Foundry Practice." Paper by Oliver Smalley.

Institute of British Foundrymen (Birmingham Branch).—Ordinary meeting at Birmingham. "Semi-Steel," Paper by Prof. A. Campion.

THE FOUNDRY TRADE JOURNAL IS THE OFFICIAL ORGAN OF THE INSTITUTE OF BRITISH FOUNDRYMEN AND THE WELSH ENGINEERS' AND FOUNDERS' ASSOCIATION.

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Foundry Plant.

It is a lamentable fact that far too many British ironfoundries are still badly equipped for the production of their regular work, and this whilst calling for greater ingenuity on the part of the foundry staff, is often responsible for the almost unavoidable wasters. Whilst many instances could be given, we will confine ourselves to two typical cases. This first one relates to an unsuitable bogey-carriage and track for use with a core oven which exists to-day in a Northern foundry. Recently, the foreman moulder complained that a heavy core for a certain job was broken each time on being transferred to the drying stove. The coremaker attempted to remedy the matter in several ways, but the core then refused to "give" when being cast, and resulted in the production of a waster casting. Obviously, no coremaker ought to be called upon to make cores to withstand innumerable jars before drying, and no one could blame him if when overcoming a mechanical trouble he introduced a more serious quasi-metallurgical one.

The second case relates to a belt-driven fan. In this case the motor has ridiculous foundations and it is out of alignment with the fan. It is the direct cause of an irregular supply of iron and the contributory cause of a number of waster castings.

To many of our readers associated with the large foundries these conditions will scarcely be realised as being possible, and will wonder why, even in the smallest of foundries, they are allowed to continue. It is because those responsible are still failing to realise that the cost of a new plant would be paid for by the loss of money of which the obsolete plant is the direct cause.

There is to be an exhibition of the latest foundry plant and supplies in Birmingham in June, and during the intervening period we suggest that foundry owners, managers and foremen should survey their obsolete plant, especially that which is thought to be swelling the "waster-loss account," and compute carefully the direct and indirect amount of money involved during the first five months of this year. We are convinced that if this were done there would be a record amount of trade done in the foundry equipment business. It is a good omen that reports from Birmingham, Manchester, and other centres all announce improved business this year in supply of new plant. Additionally, several new foundries are on the point of starting up. These are factors which every live foundryman must take into account, because well-equipped foundries are in a position to quote low prices and assure for themselves the same net profit as their badly-equipped or laid-out competitors. Many foundrymen rely far too much for ability to quote favourable prices on their plant being worth nothing in their books—it has been written off years ago. Quite often it has approximately the same market value.

B.C.I.R.A. Secretary Resigns.

Mr. Thos. Vickers has resigned the position he has held since 1919 as organiser and secretary to the British Cast Iron Research Association. Three years ago he organised the Bureau of Information on the lines advocated by Mr. R. Buchanan before the Association was ever contemplated, and also started the first library of foundry literature in this country, which is now a valuable asset of the Association's work.

Electric Furnace Refractories.*

By R. C. Gosrow, Metallurgical Engineer, Chicago, Ill.

Long life for the refractory linings of electric furnaces is largely dependent upon two factors: (1) Selection of the most suitable type of refractory for the particular operation or process; and (2) proper setting of the bricks.

A large number of refractory materials are available in the form of powder, grains, cements, lumps, bricks of standard shape and size or special shapes. The applicability in any specific instance should be determined by consideration of such properties as the softening temperature under load, chemical character, porosity, density, and susceptibility to temperature fluctuations.

Setting Lining Walls.

In order to maintain an even pressure on the brick, the surfaces of the brick must be flat, free from warp and swell, hollows and bumps. By securing the uniform bearing of one surface on another, cracking may be prevented. Most bricks as they come from the manufacturer possess surface irregularities, many of which are uncontrollable in the process of manufacture. All refractories are subjected to loaded heating. By this is meant that they are subjected not alone to high temperatures, but in addition must carry the dead-weight load of the structure. As an appreciation of this, furnace builders have so designed their furnaces that no extra load is placed on the lining walls. Although in early types of furnaces the roofs set directly on the lining walls, this is now being eliminated by setting and fastening the roof to the shell. Loaded heating, then, requires not only the maximum refractoriness of the material, but perfection in the dimensional characteristics of the brick as well.

When brick surfaces are not flat and even, they may be made so by rubbing on an abrasive surface. Softer brick such as fireclay may be rubbed against one another. Harder brick, as magnesia, chrome, silica and zircon, may be rubbed down by applying to a grinding surface. The amount of truing up necessary may be quickly determined by placing together two bricks one in each hand and observing whether they "roll" or "rock" on each other. This may appear to some to be a needless waste of a bricklayer's time, but the momentary inspection may mean a great deal to the life of the setting. In many bricks examined over a number of years, no amount of emulsion will rectify the irregular and uneven surfaces. Grinding of the surface is essential and necessary.

A very slight amount of bonding materials between the brick surfaces may at times be most beneficial, as it serves to close surface pores. But one of the bad effects of irregular bricks is that the workman fills up these surface irregularities with wet or dry materials, and then expects the structure to be stable. Where two surfaces are in intimate contact, very little material will be retained in the joint. And where the surfaces are not in intimate contact, the material used as filler or bond does not support the structure when it shifts and readjusts itself to temperature and expansion changes.

Flat, evenly bearing surfaces are essential in refractory setting. Even expansion, even contraction, and even pressure are all attained by getting the surfaces bearing at the time the setting is put on.

Closed Tight Joints are Essential.

Refractories used for high-temperature work are generally exposed to the action of highly-heated gases, vapours, liquid slags and metals. These impinge with varying force upon the surfaces and initial penetration into the refractory setting usually takes place along the lines of least resistance—the joints between the bricks.

Consider the construction of furnace side walls with the bricks set as stretchers or as headers. A standard brick set as a stretcher exposes an area of 2½ in. by 9 in., or 22½ sq. in. If the joints at each end are not tight, an additional 22½ sq. in. is open to attack, making a total of 45 sq. in. Set as a header, a brick exposes a surface of 2½ in. by 4½ in., or 11¼ sq. in., and if the end joints are open, an additional 45 sq. in., or a total of 56¼ sq. in. These calculations do not take into account the possibility of poor contacts in horizontal joints, as this point has already been emphasised in detail.

When a new lining or setting is placed in service, the material composing it is in its original manufactured state, and it should be remembered that data on the properties of refractories refer only to this condition. When the furnace has been operated for a number of heats, the material undergoes a marked change. Under the combined action of heat and pressure, changes of structure and of volume occur; solids and vapours are absorbed, the specific gravity usually increasing. The pores of the refractory become partly filled with metallic and earthy sublimates, slag and metal. The surface layers, of course, take up these materials more quickly, and the effect is here more pronounced. But the action gradually penetrates through the body of the refractory, thereby materially altering the original properties, such as the softening temperature under load, which is lowered very considerably. As the rate of penetration is not the same for all refractories, there is wide variation in the ability to resist such deterioration.

Refractory Washes.

To take an ideal condition, if the porosity of a brick could be reduced to a minimum and the area of attack or exposure similarly diminished, we should then have a material that would be subject only to fusion and not be altered in composition by the action of furnace products. The writer has a method whereby the porosity may be decreased, although the final details have not as yet been perfected. The area of exposure may be reduced to a minimum by making sure that all joints are closed tight and by allowing only the actual working surface to come in contact with the furnace products.

In connection with this appeal for obtaining closed tight joints, it is pertinent to mention the use of cements and powders manufactured and sold for this purpose by refractory manufacturers. Most of these cements and powders, however, are used in too great amount. It is not essential to cement a brick setting, as a whole, as is frequently done. But it is essential and on the whole most desirable for the brick pores to be filled before the materials within the furnace can enter them and so alter the structure that the original properties of the bricks are no longer existent. This function of cements and powders will do the most good. It is not thought that the use of cements and powders ⅛ in. thick between bricks in any manner lengthens the refractory service, but it is believed that a thin wash of these high-grade cements as pore fillers, with a surface-to-surface contact of the bricks, evenly bearing and coincident, will materially increase the life and durability of that setting. It is not alone in the bonding property of these cements that their virtue lies; the ability to close up the pores is equally important. Furthermore, to assist in closing the pores of the exposed working surface, the writer strongly recommends the use of refractory washes to the whole surface of the wall. This not only covers the joint openings, but effectively prevents the penetration of vapours and gases beyond the working surface of the lining.

Formulae for Refractory Washes.

These refractory surfacing coats have not had the attention with refractory manufacturers that they deserve. In a number of furnace settings the writer has had excellent results both on basic and acid walls with washes and plaster mixtures, of which the following are typical:—

For Basic Walls of Magnesia Brick. Mix 90 parts of dead-burned magnesia (60-80 mesh) and 10

* From "Chemist and Metallurgical Engineer" (slightly abridged).

parts of plastic magnesia (80-100 mesh) to a plaster consistency with 15.5 deg. Bé. solution of magnesium chloride or with a 25 deg. Bé. solution of magnesium sulphate. Apply with a plasterer's hawk and trowel to about ⅛ in. thickness and dry in air for about 10 hours. If a thicker coat is desired, apply again. Usually a coat greater than ⅛ in. thickness is not as durable as one of this thickness.

For Acid Walls of Silica Brick. Mix 98 parts of pure silica powder (80-100 mesh) and two parts of portland cement with warm water to a plaster consistency, and apply with a plasterer's hawk and trowel to about ⅛ in. thickness. Dry in air for about 10 hours, and burn in with the furnace. Or mix 97 parts pure silica powder (80-100 mesh) and three parts best-grade fireclay with warm water to a plaster consistency, and apply with a plasterer's hawk and trowel to about ⅛ in. thickness. Allow to air-set for 6 to 8 hours, and burn in with the furnace.

Allowing for Expansion.

The linear expansion of brick is sometimes considerable in a furnace wall. Take for an example a silica-brick wall in the lining of a furnace, for horizontal expansion.

A circular furnace of 72 in. inside diameter, with a wall thickness 9 in. of lining-header bricks. The diameter on the neutral circle is computed: (72 in. + 9 in.) × 3.14 = 254.3 in. Expansion of silica brick at 1,700 deg. C., 2.5 per cent.; 254.3 × 0.025 = 6.35 linear expansion. Deducting this from 254.3 leaves 248 in., which is the distance the bricks must cover in the cold condition; 248 divided by 4.4 equals 56 bricks in the circle. The 6.35 in. must be provided for by the use of expansion fillers which will crush when the expansion pressure is exerted on them. Therefore wooden fillers are used, and in this case 12 fillers of ¼ in. thickness, equally spaced around the circle, will accommodate the expansion.

This allows for horizontal expansion only. The vertical expansion will be taken care of, because the lining wall is free to move in a vertical direction, having no restrictions at the top.

Here we come again to the necessity of even bearing, surface-to-surface contacts in brick settings. Where such conditions exist and the structure is built with uniform flat bearing surfaces, expansion takes place uniformly and evenly throughout the mass. The subsequent contraction is also uniformly distributed and the whole mass moves as a unit and not indifferently, as is the case when bricks are not in contact, under unequal strains and bearing unequal and distorted pressures.

Header and Stretcher Courses.—The setting of brick as headers or stretchers has been referred to under the previous paragraphs. It seems to be the general practice to set bricks as headers in furnace lining walls. This practice gives a more stable construction to the wall; it presents to the furnace heat and products of the furnace the most resistant part of the brick, the end, and it maintains integral a wall of proper working thickness before renewal is necessary. By the keying of the circle bricks, the structure is made self-supporting, when the furnace is tilted for pouring.

Backing Walls and Hearths.

Backing walls may be considered as the permanent walls of the furnace. A backing wall is usually laid permanently against the furnace shell, and acts as a retaining wall for the lining and a protection to the steel shell.

The use of backing walls in electric steel furnace construction is general practice. When only a lining wall is used, operators run until it approaches too near the shell and then reline the whole shell. By the use of backing walls, a constant protection to the shell is provided. For the lining wall is all that is corroded, and the backing wall is never allowed to melt or flux out. The use of a backing wall also reduces the amount of high-grade refractory required for the lining wall proper.

Backing walls may be set up of No. 1 fireclay brick or of silica brick. The backing wall should be set carefully, solidly and with the idea of permanency. It is advisable to set up backing walls with thin wet wash between contacting surfaces. Avoid the use of bats and fine filling material to fill up holes and irregularities in the brick setting. Make the wall true to the form of the furnace shell, and give it a slight flare on the inside to the top. A slope of about ¼ in. per foot of height is sufficient. It is also good practice to set a ⅜-in. asbestos sheet against the shell and build the backing wall directly against this. This allows for expansion and movement of the setting.

The brick base of furnace hearths should be set up dry. This is an advantage for many reasons: (1) There is no necessity of drying out after setting; (2) there is no brick deterioration from steam formed during the drying periods; (3) bottom-making material may be put in and burned as soon as the brickwork is finished; (4) it requires careful brick-setting, and no filling of cracks and openings with wet filler and bats is permitted; (5) it makes a foundation for the sintered bottom with no moisture content whatever.

The hearth brick should be set up to conform to the shallow saucer-shaped bottom of the furnace. It is not essential that the bottom of the furnace shall be saucer-shaped, but the inner contour of the bricks may be given this shape. Although now in most types of furnaces the bottom shell plate is curved, so that by setting the hearth brick on end they conform to the bottom and produce the saucer-hearth shape desired.

Essentially the banks of the furnace are designed to eliminate deep, sharp corners in the metal bath. Where the side vertical walls and the bottom meet there is an angle of 90 deg. and over. It would not be practical to handle a heat of molten metal with a cross-section like a rectangle. So in order to eliminate the sharp corners and the attendant undercutting action that would take place on the side walls, this angle is filled in and a fillet is formed, better known as the "banks" of the furnace. The banks are usually formed of refractory material in the form of ⅜-in. and ½-in. grains. They protect the side walls from cutting action of slags and also give the metal bath a thin section on its periphery with gradually increasing depth toward the centre of the furnace, where the major part of the heat is generated and where the mass of the metal can take up this heat.

As the angle of rest for the material used and the size of the material determine the slope of the banks, the maintenance of the banks is dependent on these factors. Naturally every melter wants to "lay" the material just where it is needed, and the flatter the slope of the banks, the easier his task becomes. But there are limitations in the width of banks that may be maintained.

The hearth of the furnace is the hardest-worked part of the furnace refractories. Yet its long life is secured by the facilities for patching and constantly repairing it after each heat. The fact that the hearth is horizontal and the banks are at a comparatively flat angle makes it easy to get materials to lie where they are needed for repairing. In no other part of the furnace lining is this so. As a consequence the hearth of the furnace has the longest life, and a properly burned-in hearth will last from 18 to 24 months.

Electrode control will materially affect the wear and cutting of the hearth. Frequently electrodes have been known to bore their way right down through the hearth. This is, of course, poor workmanship on the part of the operator, and indicates a lack of control regulation on the regulating equipment.

Roof Problems.

Furnace roofs present many problems on electric furnaces. The problem all operators are trying to solve is to get material and construction that will give them the maximum tonnage from a roof. As soon as a roof completes a service that is in excess of any previous service, the facts are at once made known to the industry and duplicates of that particular roof are in demand.

Furnaces are now built and operating with roofs of various materials and of various types of construction, such as silica brick roofs, most generally used; magnesia roofs, gradually being replaced by silica; carborundum brick roofs of Carbofrax brick; monolithic roofs, in which the material is tamped in a form, dried and burned; dome-shaped roofs; single arch roofs; flat centre roofs, in which

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the centre brick are special shapes around the electrode openings; fixed roofs, built *in situ* and removable only when the roof is taken down; removable roofs, in which roof is laid up and held to form by a roof ring or a structural form as in the case of square and rectangular roofs; lifting roofs, in which the roof lifts back (like the lid on a box) for charging the furnace; water-cooled roofs, in which the supporting ring is a water-cooled casting.

The mechanical design of the roof is a feature that is often dependent on the particular furnace and its characteristics of operation. The material composing the roof refractory is a factor that bears quite a similar relationship to the design of furnace and its operating characteristics.

Silica brick is the most universally used refractory in electric furnace roofs to-day, whether for acid or basic melting and refining. This general practice has been adopted for many reasons, of which the following are typical: (1) The high-softening temperature of the material; (2) the moderate first cost of this refractory, as compared to other high-softening-temperature refractories; (3) its applicability to acid and basic furnaces alike; (4) the ability for manufacturers to produce special and large shapes of this material; (5) the good results obtained without the necessity of water cooling; (6) the comparative freedom from cracking and excessive spalling with wide temperature changes.

Setting up Roofs.

By a series of observations, tests and experiments under actual operating conditions it has been proved that the roof that is set up with the bricks fitted and with close contact surfaces all bearing gives a longer operating life and greater tonnage than one not so carefully and mechanically constructed. The life of the roof may be computed in "hours on load," "tons produced," "tons melted" or "ton-hours."

Roof deterioration is traceable to two prime causes: (1) Slagging and melting, due to fluxing of the refractory by dust and vapours, which come from the ingredients of the charge. The subsequent softening and melting consumes the material. (2) Cracking and spalling, due to unequal bearing pressure on the individual bricks in the setting and to susceptibility to temperature changes. The spalls soon drop out and the arch is consequently weaker. The first cause may be eliminated to a considerable extent by furnace operations. The second cause may be eliminated by suitable and proper construction.

All furnace roofs are constructed on the principle of the arch. This principle, when properly applied, makes the structure capable of supporting its own dead weight of material. The vertical weight of the material is transmitted laterally through each member, in the setting, to the skew bricks from which the arch springs and which are in turn held in position by the containing ring or wall. Strength in such a structure as this depends entirely upon the load being uniformly and equally distributed to each member. If any member in the structure is not carrying its quota of the load, that member is not a part of the structure and will either fall out or crack from the unequal pressure exerted upon it.

When a roof is placed in service, it is at once subjected to heating, which brings about expansion. Immediately every brick assumes, or tries to assume, the position in which it will fit snugly with adjacent members. In most of the roofs constructed, only about 60 per cent. of the total brick area available for contact bearing functions properly. It is apparent that this condition cannot make for a strong structure, for as soon as expansion takes place a change in volume results and bricks are cracked by the unequal stresses which develop. On cooling, the volume reduces and the spalls fall out.

The cause of this trouble is easily located and may be rectified. It has been the experience of furnace builders, operators and refractory makers that roof brick should be made specially to suit the curvature of the arch for the required thickness of roof. Each brick, therefore, is keyed brick, which accurately fits into the structure with its adjacent member. It was recognised that ordinary brick would not give the fit required for the strength of the structure and for the proper distribution of the load through each member. The improvement was in the right direction. But imperfection still exists, and what is wanted is true, even, flat surfaces on the contact-bearing surfaces of the brick. To attain this may require some changes in the brick manufacturing process, but this improvement should be in line with the desire of every manufacturer to perfect his product. Why make a brick with a $4\frac{1}{2} \times 9$-in. surface if it is possible to utilise only 50 per cent. of this surface for bearing, because of hollows and bumps?

Practical Hints.

Roof brick should be set up dry without water emulsion bond or filling. But sealing of the joints is important. Tar-dipped brick very effectively seal off the joints and fill the surface pores. Dipping in tar has three beneficial results: (1) Closing the joints by the residue of coke left after heating up the roof; (2) closing of surface pores of the brick; (3) the coke residue forms an effective resistance to the penetration of gases, vapours and sublimates into the joints. Wood expansion fillers must be used on all silica-brick roofs. Allow $\frac{1}{4}$ in. expansion for each 10 in. on the arch.

Dry sand filling and cement fillings, when made thick between joints, are of little advantage in roof setting. Covering a roof with sand or cement on the outside is injurious to the durability of the roof. The top of the roof should be kept clean and free from such materials. Brick masons have a habit of smearing the outside surface of the roof with washes and cements after the brick are set up. Refrain from such practice, as the accumulation of material on the top of the brick causes hot spots and premature burning out of those spots.

The thickness of a roof is not determined by theory or by calculation. It is determined from practice and experience. It has been found that the thickness of a furnace roof is determined by the furnace itself, and all that is required is to observe the result. A roof of unnecessary thickness is no advantage. The excess will melt away. The radiation from the roof and the conduction of heat through the roof must at all times be such that the inside surface temperature does not exceed the melting temperature of the refractory. The thickness of the roof is the determining factor and the roof will melt until equilibrium is established. A roof of too great thickness constructed of any material having a melting temperature within the range of the operating furnace temperature will thin itself by melting away. In general practice to-day furnace roofs are constructed about as follows:—

250 to 1,000 kva., $\frac{1}{2}$ to 4 tons capacity, 9-in. silica roof.

1,500 to 3,000 kva., 5 to 10 tons capacity, 12-in silica roof.

For truing up irregular surfaces the same practice may be followed as outlined for lining walls. Considering the difference in structure between a wall and a roof, it may be readily appreciated how important this feature becomes in roof construction.

General Conclusions.

Much of the improvement in refractory service must come from the refractory manufacturer. Inherently much of the value of the refractory exists in what the manufacturer puts into it.

The intelligent use of the materials by the furnace operator is essential. Refractories must not be exposed to the weather. They should be stored in a building where they will be kept dry and at an even temperature.

The wide range of results from the use of furnace refractories shows that greater knowledge and skill is required in their use. Much of the variation is caused by mechanical imperfection.

A brick is just as much a factor of importance in a refractory setting as a steel section is in a structural steel fabrication. Its physical dimensional features are important.

A more intelligent use should be made of cements and pore-filling materials. These materials should not only be sold and put to use as so-called binders, but they should be used to fill pores and close off joint cracks More extended use of such refractory cements for wall plasters should be advocated; and their use in thin washes only (not $\frac{1}{4}$ in. thick) when used in joints.

Modern Automobile Foundry Practice.*

By P. Pritchard.

(*Continued from page* 172.)

Cylinder Casting.

The most important grey iron casting on an automobile is undoubtedly the cylinder, and the manufacture of cylinder castings to-day, owing to the intricacy of the designs, has reached a stage which would have been deemed impossible twenty years ago. Exceptional care during every process involved has to be taken in the manufacture of a cylinder casting, as the slightest deviation from the set procedure would result in scrap castings.

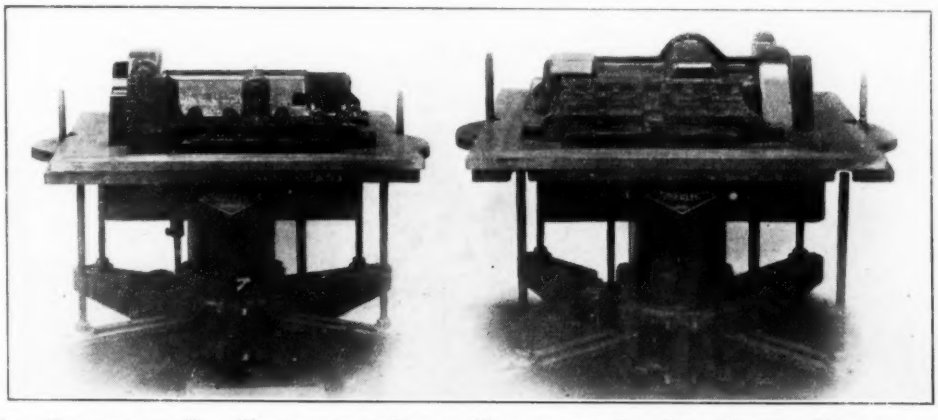


FIG. 18 SHOWS THE TWO HALVES OF THE PATTERN MOUNTED ON A JOLT RAM MOULDING MACHINE.

In the first place the patterns and coreboxes from which cylinder castings are produced must be very accurate and well made, as the thickness of the metal is usually cut as fine as possible. Mahogany patterns are sometimes used, although it is preferable to use metal patterns. The moulds, when quantities permit of the expense involved, are made on machines. Dry-sand moulds in this country are nearly always used. The cores made from oil-sand absorb a large proportion of the productive labour used on cylinder work. The setting of the cores and closing of the moulds is without doubt the most important operation, because upon it depend to a large degree the accuracy and soundness of the final casting. It is essential that all cores should be set in position to gauges and then fixed tightly in their places, as the lifting force exerted by the fluid iron when entering the mould is considerable, and the slightest movement of the cores would result in a spoiled casting. It is principally for this reason that the designer should wherever possible allow sufficient apertures for holding the water-jacket cores in place either by providing large water inlet and outlet passages, or alternatively by inserting special core-plug holes.

Figs. 18 to 27 illustrate the different stages in the manufacture of a water evolved cylinder casting which is cast integrally with the cylinder block.

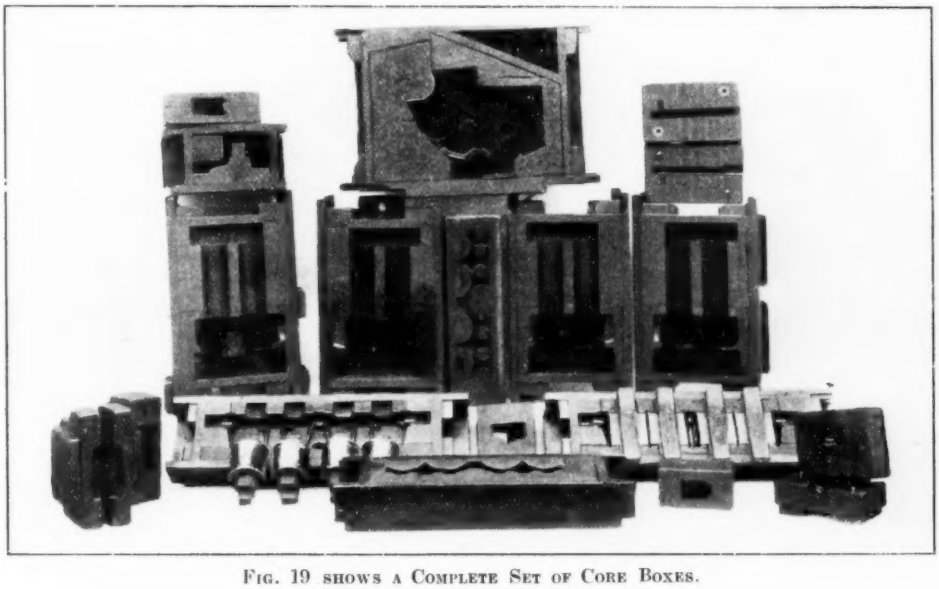


FIG. 19 SHOWS A COMPLETE SET OF CORE BOXES.

* A Paper presented to several branches of the Institution of Automobile Engineers. Mr. Prichard is a director of the Midland Motor Cylinder Company, Limited, and is also connected with the Birmingham Aluminium Castings (1903) Company, Limited, and the Pneulec Machine Company, Limited.

The Metal.

It is essential that the metal from which cylinders are made should conform to the following requirements:—

(1) It should be capable of being readily machined; (2) it should be able to withstand hydraulic pressure and also high gas pressure; (3) it should possess good wearing qualities; (4) it should possess a fair tensile strength especially at high temperature, and (5) it must be fluid in order to fill quickly every portion of the mould.

Whilst it is possible to make satisfactory cylinder castings from very many different mixtures of metal, each giving analyses varying in some degree, a good all-round specification is the following:—

T C between 2.6 and 3.4 per cent.
Si between 1.25 and 2 per cent.
P under 0.9 per cent.
S under 0.120 per cent.
Mn between 0.6 and 1 per cent.

This does not mean to say that any iron within the limits of the above analysis would make good castings; much would depend upon the relationship between the elements mentioned. The total carbon content is important, and also the percentage of silicon, as upon this depends to a large extent the hardness of the material.

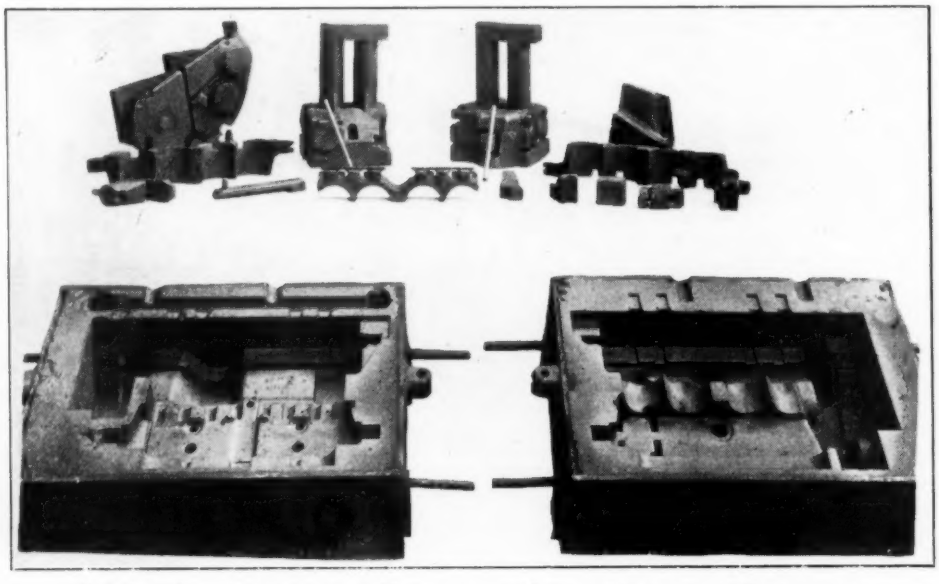


FIG. 20.—TWO HALVES OF THE MOULD WITH A SET OF CORES IN THE BACKGROUND.

Some Defects in Cylinder Castings.

It is not too much to say that the greatest obstacle in the way of a cylinder founder is the difficulty of getting his material to conform to all the conditions required in the castings. The average cylinder is of necessity an intricate casting in which the thickness of metal varies from $\frac{1}{32}$ in. in the jackets to heavy lumps and bosses (as for valve and tappet guides, etc.) one or even two inches through. Frequently, too, when the centres are close the walls of the cylinders are merged together and form very heavy sections of metal where they adjoin. It is the difficulty of getting a cast iron which will give the required density and hardness in these heavy sections, without the thinner portions of the casting (such as valve shields, water outlet facings, etc.) being too hard to machine, that presents the greatest problem. The hardness of cast iron depends to a very considerable extent upon the rate of cooling; the longer the time taken for the metal to set and cool to black heat, the greater the amount of combined carbon converted to graphitic carbon, and consequently the softer the casting. It is obvious that thin sections of metal will cool more quickly than heavy sections, and in consequence these portions of the casting will be much harder than such heavier sections as the cylinder bores.

Now silicon in the iron, as mentioned previously, has the effect of converting the combined carbon into graphitic carbon, and so softening the metal, but whilst it would be possible by raising the percentage of silicon to make the thin portions readily machinable, this would automatically cause the heavier sections to be too soft and consequently open metal with leaky cylinder walls would result. On the other hand, if the silicon were reduced so as to make the heavy sections close-grained and of sufficient hardness, the thin sections would be much too hard for machining.

Again, the average founder has to make cylinders of different designs and which vary greatly in weight and thickness of metal, and whilst it is often possible to obtain an analysis of iron which will give excellent results on one design of cylinder, it is most probable that this same grade of metal would be entirely unsuitable for a cylinder of different design. It is not practicable, when using a cupola for melting, to use very many different mixtures of metal, owing to the difficulty of separating and classifying them, and it is mainly in view of this that the author predicts that a change will ultimately be made in melting practice from the cupola to the open-hearth or some similar form of furnace which will give more accurate control and greater flexibility. So far, however, this problem has not been tackled by the foundry engineer with any degree of success.

Another very closely allied cause of difficulty in cylinder castings often arises when the casting is so designed that two adjacent heavy sections of metal are only separated by a thin wall of sand. A typical instance of this is in the casting of a cylinder where the centres of the valves have been cramped in as close to the centres of the cylinder bores as it is possible to get them. This has the effect of cutting the sand of the water-jacket core behind the valve springs very fine. Consequently

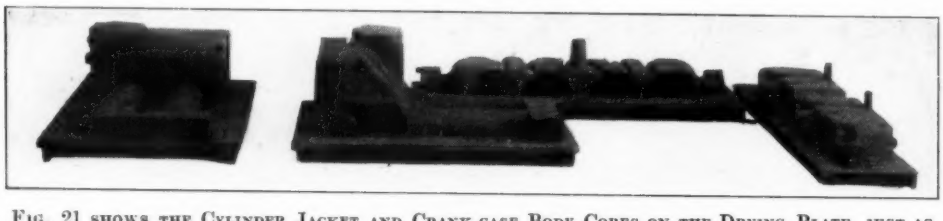


FIG. 21 SHOWS THE CYLINDER JACKET AND CRANK-CASE BODY CORES ON THE DRYING PLATE, JUST AS THEY HAVE BEEN TURNED OUT OF THE BOX AND READY FOR DRYING.

owing to the conduction of heat from the metal of the jacket through these fine pieces of core sand to the metal of the cylinder wall the rate of cooling of the latter is delayed, with a resulting openness and often porosity in that portion of the cylinder bore adjacent to the valve-spring chamber. The author has recently come across instances of this kind where large numbers of cylinder castings, representing many thousands of pounds in money, would have been saved if the design had been arranged to prevent this too close approximation of metal. A similar instance occurs when two or three heavy bosses are placed very close together.

Very fine water-jacket spaces in most castings are not only expensive to produce (out of all proportion to the benefits obtained), but are frequently the cause of defective castings, with consequent loss to both maker and user. It is not too much to state that there is no casting on the modern automobile in which more trouble and money can be saved by prior consultation than in the cylinder block. Frequently a vast amount of expense and delay could be avoided if before a design were finally settled it were submitted to the experienced foundry engineer for comment as to possible casting difficulties viewed in the light of his experience.

Unfortunately, however, the experienced foundryman with sufficient knowledge of internal combustion engineering to know what requirements in design are essential and what are not, is all too rare. This is a point which it would pay many firms to consider seriously. We have expert opinion available upon all sorts of subjects ranging from, say, the heat-treatment of steels to the behaviour of different types of fuels, but the author has yet to find a firm in this country who have in their employ a person fully qualified to advise them on such matters relating to design and foundry practice as described above. This point is surely worth the attention of some of our younger students and apprentices to automobile engineering. There is a great dearth of this class of man, and the supply of them would soon bring about recognition of the value attaching to their services.

Second, perhaps, in importance to defects in cylinder castings due to unsuitable metal are those caused by inaccurate castings. Cylinder castings must of necessity be very accurate as, in the first place, the section of the metal is usually kept as thin as possible and admits of practically no variation, and, secondly, errors in dimensions of certain portions of the castings (*e.g.*, combustion spaces, inlet and exhaust passages) will impart varying results to the performance of the engine. On this account it is necessary not only to check by means of gauges both the core and the mould, but also by the use of templates and jigs to ensure that the cores are correctly located in the mould. In addition to this it is highly advisable for the foundry to have its own inspection department, where every casting can be viewed for general defects, gauged for accuracy, and hydraulically tested for soundness, before leaving the works.

It occasionally happens that during machining large or small clear round blow-holes develop in the cylinder bore or other parts of the casting, which may in some instances be due to unsuitable metal. They may be caused also through the gases generated from the cores by the hot metal not escaping through the proper channels or vents provided, but, instead, forcing their way through the molten metal and getting trapped therein during solidification. This is an added reason why sufficient openings to water-jacket spaces are needed, in order to allow of free escape of these gases.

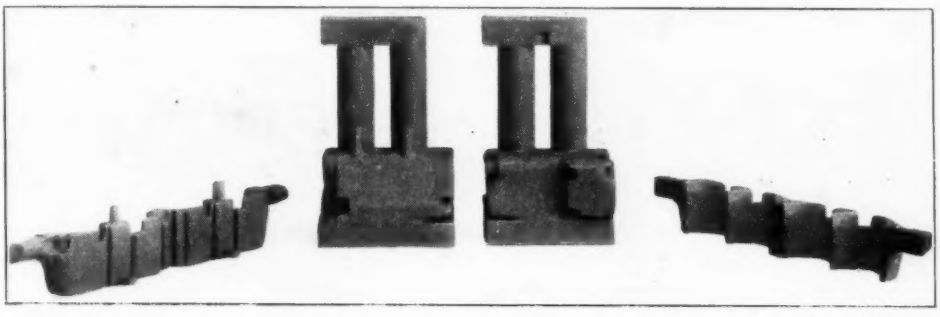


FIG. 22 SHOWS THE SAME CORES AFTER BAKING, BLACKING AND READY FOR INSERTION IN THE MOULD.

In other cases, the machinery of a casting discloses pieces of dark foreign substance in the metal; this is usually rubbish and is either caused by:—

1. Loose sand getting carried into the interior of the mould by the metal, or a portion of the mould breaking away before or during casting.
2. The plumbago used to face the moulds and cores peeling off under the flow of the metal and becoming intermixed with it.
3. Rubbish or slag from the metal itself being drawn down the runner holes provided for filling the casting by the natural suction of the metal.

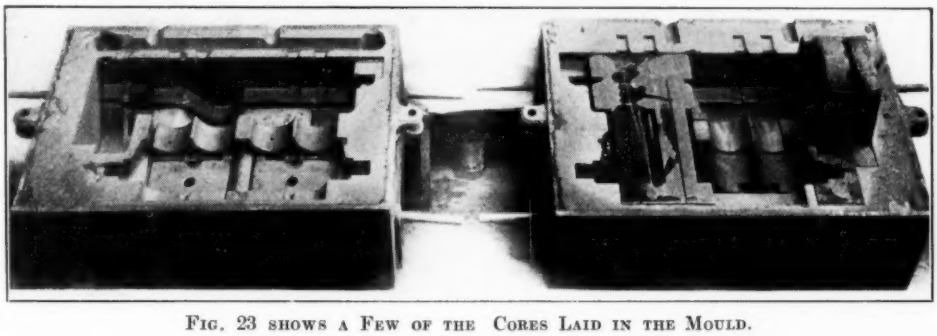


FIG. 23 SHOWS A FEW OF THE CORES LAID IN THE MOULD.

The presence of sand and flash in the water passages of the cylinder is another source of trouble to the engineer. This can usually be overcome by using a suitable core sand and providing a sufficient number of plug holes for removing them, together with careful joining together of the various cores. It often happens that owing to very intricate design it is impossible to insert the various inlet and exhaust port cores inside the water jacket cores without having a number of joints and loose pieces of core. In such a case it is frequently difficult to ensure that each joint is properly sealed, as, for instance, where the cores can only be built up pieces by piece inside the

mould. This means that when the whole process is completed all the joints cannot be got at to ensure proper sealing. In such cases quite a small alteration in design will often overcome the difficulty.

The above are, of course, only a few of the possible causes of defective castings, and the list could be extended *an infinitum*, but no useful purpose would be served here. One thing, however, is worthy of note, and that is that all the points here mentioned, whilst relating more particularly to cylinders, are applicable in a greater or lesser degree to all iron castings used in automobile work.

Centrifugal Casting.

Although first discovered a number of years ago it is only very recently that centrifugal casting has been brought into successful use. The process depends upon the principle that a body rotating at

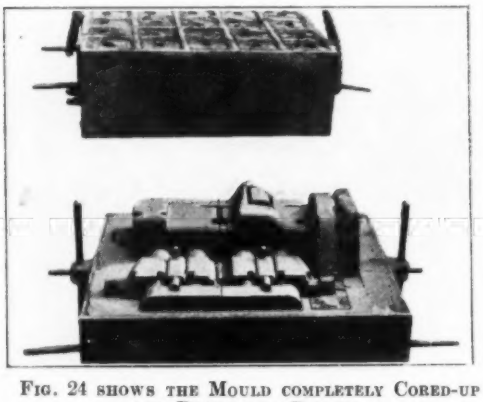


FIG. 24 SHOWS THE MOULD COMPLETELY CORED-UP AND READY FOR CLOSING.

considerable speed tends to fly outwards away from the centre of rotation due to the centrifugal force exerted. This law is applied to the manufacture of castings.

The moulds or dies used are, of course, permanent, and are generally made of either cast iron or high-grade steel. The chief castings produced by this method for automobile work are piston ring pots, cylinder liners, sleeves and other cylindrical or uniformly circular castings. For making such things as sleeves and plain castings the mould or die is rotated about its horizontal axis at a speed varying from 400 to 1,000 revs. per minute according to the diameter of the article to be produced. The die is open at both ends, the molten metal being poured in whilst it is rotating. The centrifugal force exerted by whirling the metal around

FIG. 25 SHOWS THE MOULD BEING CAST BY MEANS OF RUNNER WELLS OR BUSHES.

inside the die causes it to fly outwards away from the centre of rotation. The molten metal is thus distributed over the mould surface, and by virtue of the centrifugal force a long tube of metal of very even section is formed.

The thickness of the material produced is governed by:—(*a*) The quantity of metal introduced into the mould at a time, and (*b*) thickness rings, similar to a piston ring, which are inserted at each end of the die to prevent the metal flying out endwise.

The thickness of these rings determines the thickness of the sleeve or liner, as any excess metal is thrown out by the centrifugal force. In a remarkably short time the metal sets and the rotation of the mould is stopped. The casting is withdrawn whilst still hot and allowed to cool normally.

Amongst the chief advantages claimed for this method of producing castings are:—

1. The high rate of production and consequent economy due to the fact that the one mould will make a large number of castings.
2. The absence of cores.
3. The automatic uniformity of section owing to the evenness of the centrifugal force.
4. The closeness of grain of metal due to the rapid cooling and also in a lesser degree to the pressure exerted by the centrifugal force.

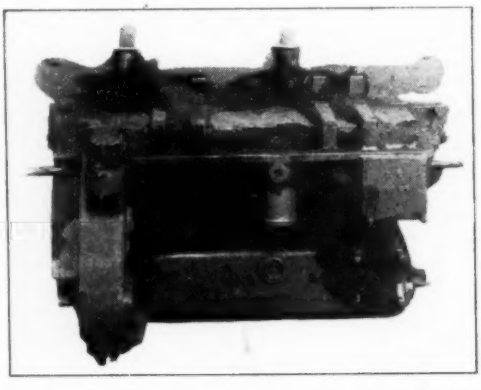


FIG. 26 SHOWS THE CASTING JUST AS IT LEAVES THE MOULD.

5. The higher tensile strength of the metal owing to the fact that the graphitic carbon in the material separates out in a very finely divided state.
6. The process dispenses with all sand generally required in making cast-iron articles.
7. The better wearing qualities of the material so produced owing to the rapid cooling.

It is, of course, necessary in order to counteract chilling effect of the mould to use metal with a

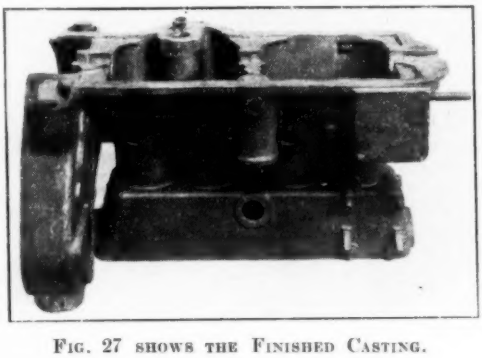


FIG. 27 SHOWS THE FINISHED CASTING.

fairly high percentage of silicon, usually in the region of 2.5 per cent., as otherwise the castings would be much too hard to machine. At the moment, this process has only been applied to making cylindrical castings of varying sizes or similar articles of uniform sections.

(To be continued.)

Salaries in the Engineering Profession.—The Society of Technical Engineers has taken a census of the salaries at present paid in the engineering profession. From the summary of the information collected on the subject it appears that salaries of staff engineers in 1923 averaged from £150 at the age of 22 to £555 per annum at the age of 50. These averages have been obtained from all the figures returned, including salaries as high as £1,500, and cover staff engineers in many different sections of engineering.

The Cylinder Problem.*

By O. Smalley, M.I.Brit.F.

(*Continued from page* 177.)

Porous or Spongy Patches in Cylinder Bore.

Fig. 23 shows sections through defective l.p. marine-engine steam cylinders which were rejected on account of local patches of open texture in the bore. The defects manifested themselves in the final machining operation at positions in the cylinder where heavy sections merge.

There are instances where the problem of design was aggravated by the moulder, who, in endeavouring to give a good finish to his mould, unwittingly increased the dimensions of the fillets. To remedy the former the fillets were removed from the pattern, and an iron of shorter freezing range and high degree of solidity penetrating power was used.

Other causes of porous or open patches in the bore are: Melting cold, low pouring temperature, method of running, temperature of mould and wrong metal. To control the temperature, the author uses an immersion thermo-couple. The temperature of the pouring is adjusted according to the types of cylinder, their dimension and the metal used. Hard and fast rules cannot be laid down. The temperature figures range from 1,310 deg. C. for a large l.p. steam cylinder to 1,380

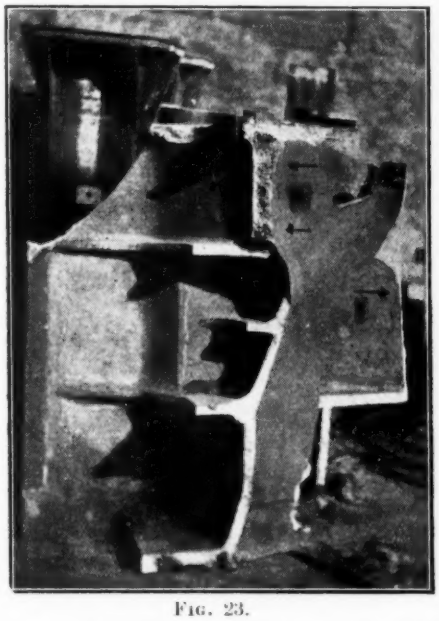


FIG. 23.

deg. C. for a small automobile cylinder or a Diesel cylinder.

Equally important with temperature is the dimension of the pouring dish and the method of running factors determined by the dictates of experience. The safer practice is to use a deep pouring basin made in hard baked loam, which holds approximately one-third of the weight of the metal required for casting, and to run as slow as possible by means of both bottom and top runners, the former to ensure a steady filling of the mould with clean undisturbed metal and the latter to lift any scum adhering to the moulds and cores, and provide a supply of hot metal at the top of the casting.

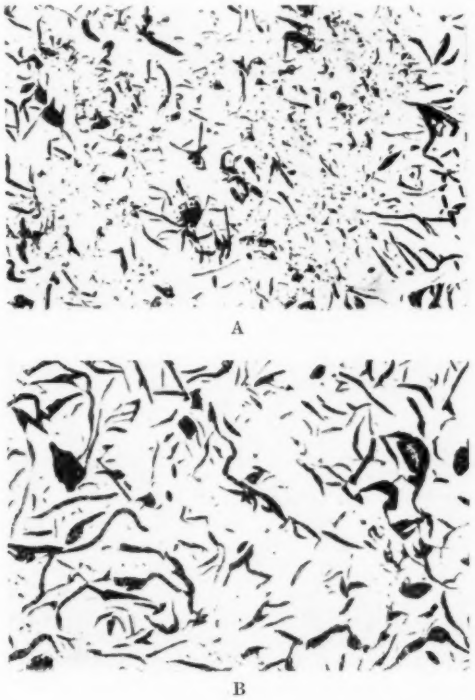
These remarks apply whether the casting is poured horizontally or vertically. Generally it is preferable to cast vertically, with the closed end up to ensure a good flow of metal through the barrel. Where casting vertically is not convenient, running off one or more risers is recommended. Such practice achieves two ends: it washes out any scum adhering to either the cores or mould and brings about uniform conditions of crystallisation.

Porous patches resulting from entrapped scum are easily differentiated from those caused by selective crystallisation. The former exhibit a bright silvery appearance, and on close examination appear to consist of numerous minute blow-holes, whilst the latter appear crystalline. Confirmation of a decision may be obtained by means of a sulphur print. If due to entrapped scum, the high sulphur is shown black; if due to selective crystallisation the sulphide is normal and uniformly distributed.

As a rule, porous patches from entrapped scum may be traced to the metal having been rushed into the mould through bad pouring, or from the use of a too shallow pouring dish, from pouring cold, the use of dirty metal, or from too much steel.

Porous Patches from Selective Crystallisation.

Carbon.—Photomicrographs A and B, Fig. 24, show the microstructure of normal and open texture of a cylinder made from pig-iron containing a high total carbon content, which was rejected on account of a porous patch in the barrel.



A

B

FIG. 24.

Phosphorus.—Phosphorus considerably extending the freezing range of cast iron is, however, the worst offender, and its presence even in small quantities is the commonest cause of porous patches. The effect of phosphorus on the process of solidification of a cast-iron cylinder may best be followed by the aid of a transparent cylindrical mould and some prepared coloured molten wax which freezes through a range of temperature. The surface of the vessel may be rough or highly polished, but if it is a poor conductor of heat, crystal growth will be observed to commence from within and from the surface at the same time. The slower the rate of cooling, the greater the chances for internal crystallisation and of floating crystallites, preventing uniform crystallisation and distribution of the lower melting point eutectic. For the same reason any condition operating in the manufacture of an iron casting of cylindrical form which results in such a mode of crystallisation—whether due to the composition of the iron, a reduced cooling surface, the use of hot or warm cores, or of cores bonded with a combustible heat-generating substance such as linseed oil, or method of pouring—

*A Paper read before the Sheffield, Birmingham and Coventry Branches of the Institute of British Foundrymen and the North-East Coast Institution of Engineers and Shipbuilders.

will assist in the formation of local patches of open and weak texture.

Blow-holes.

Blow-holes arise from the phenomena of solution of certain gases in melting, from the dissociation of certain chemical compounds and from chemical reactions. They may, therefore, be located to occluded gases, mechanically contaminated oxide, or to a simple chemical reaction in the metal itself, or between the scum or oxidised surface of the iron and the main body of metal

When resulting from poor melting conditions their origin may be traced to the use of low-grade pig-iron, scrap or steel, badly dimensioned stock, inferior coke, low coke bed, too low coke ratio, too high blast pressure, wrong fluxing or any condition which tends to oxidise the metal or melt cold. On the other hand, semi-steel or iron, high in sulphur, if poured cold, will blow as a result of dissociation of the sulphur compounds. These, however, cannot be directly attributable to bad melting, their elimination being a question of shop organisation. Such blow-holes usually exhibit a bright skin. They are accompanied by a general unsoundness of the casting and in some instances free oxide of iron may be found.

Blow-holes resulting from overlaps in running or from a reaction between the scum and the metal, are local to some particular portion of the casting, and exhibit a tinted or blackened skin. These are caused by wrong gating, the use of a too small pouring dish, careless skimming or entrapped foreign matter such as may be lodged in some portion of the cylinder which does not permit of a free flow of the metal.

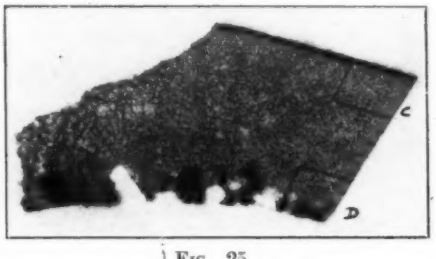


Fig. 25.

Fig. 25 shows an etching taken through a section of a cylinder casting barrel at a defect of the blow-hole type. It shows the extent of sulphur segregation in the immediate vicinity of each blow-hole, whilst in the rest of the cylinder it is normal and uniformly distributed. Photomicrograph A, Fig. 26, shows the microstructure at the position C of etching B, Fig. 25. Photomicrograph B and C, Fig. 26, show the nature of the iron in the vicinity of the blow-holes, the pale granules and brownish-black patches being sulphide of manganese and oxide of iron respectively. The actual sulphur content at the segregation of this sample was 0.67 per cent. against 0.063 in the rest of the cylinder.

This examination points to the entrance of scum from the ladle into the mould, entrapped by port cores functioning as skim gates. The remedy is self-evident, and lies either in the use of bottom pouring ladles or a larger and deeper pouring dish which will permit the scum to rise to the surface, or by casting vertically and flowing some metal off through one or more risers.

Design.

Having considered design in its relation to moulding principles and the metallurgy of cast iron, we may now proceed to the general aspects of the subject.

A well-designed casting might be said to be one that can be made commercially and whose sections are no thicker than is essential to the desired unit of strength and which are evenly proportioned so as to avoid local slow cooling.

Design and Economy.—From the engineer's point of view, a design that will save machining, fitting, handling and weight is desirable, but considered without a knowledge of the metallurgy of cast iron, moulding methods, difficulties and cost, defeats its own end and may prove more costly in the long run. The cheapest design is that which presents least difficulties and risks in manufacture. Cylinder castings, however, are never simple, and cut prices do not assist in the successful production of sound cylinder castings. After deducting establishment charges, cost of metal and profit, the common procedure with cut prices is to barter with the moulder and core-maker to accept that figure which may be left for them. Cylinder moulding requires a consummate skill and conscientious workers who will give the closest attention to the minutest details. These qualities are not to be obtained from either dissatisfied or incompetent men.

Design and Evolution.—One cannot overemphasise the importance of a closer active co-operation between the engineer and the foundryman. Where old designs have been modified to meet new and more stringent conditions, overhaul in the light of recent foundry research would well pay for the time and trouble expended. Recently the author was consulted in the manufacture of a

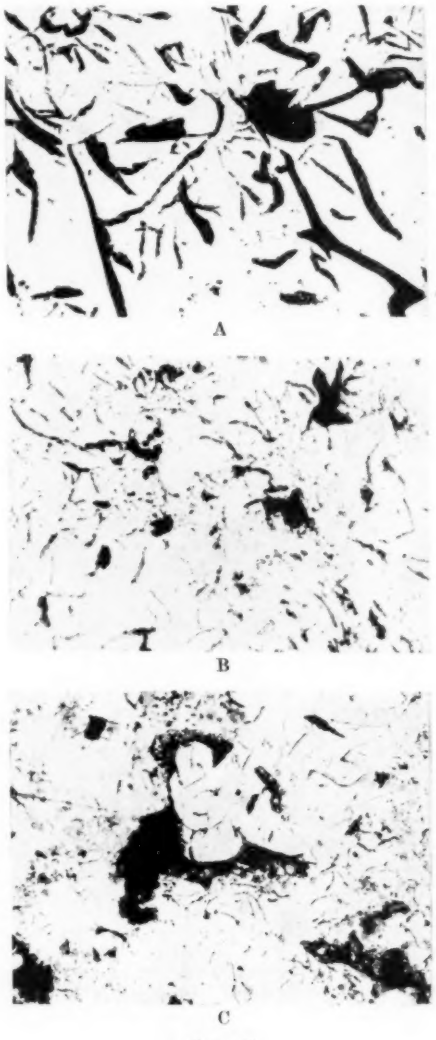


Fig. 26.

superheated steam locomotive cylinder of a somewhat complex design, which gave trouble to all the foundries that attempted manufacture, whilst some of the cylinders that passed inspection cracked after short service. The cylinder design was old and had evolved to meet modern conditions. After modifying the section of the ports, removing unnecessary ribs, bosses, drain-holes, flanges and an anti-vacuum valve passage, which was attached to the steam chest, but which was not used, commercial manufacture of reliable cylinders became possible.

Modern Design.—Freaks of this nature, however, are still encountered in new designs, and

castings are requested daily in which no consideration has been given to strength (other than that of assuming cast iron to be an unreliable material of construction) or to venting and removal of cores.

Grey cast iron is a material that may either expand or contract on solidification, but which under normal conditions of manufacture expands. The placing of large masses of metal, therefore, at the top of the casting for feeding purposes—a desirable feature in the designs to be made in steel, brass or other freely contracting alloy—is to be avoided. Cast iron cannot be fed in the same way that steel can, and feeding heads placed on thick sections of iron castings to attempt to eliminate draws aggravate rather than minimise the defect. For this reason, heavy masses of metal or various sections conjoining, if essential in the design, should be placed somewhere within the casting, proportioning the sections so that there is a gradual change in their thicknesses, and so that a free flow of metal will be obtained. Where the sectional changes are abrupt and not uniformly proportioned, one portion of the metal will remain fluid and feed those sections which freeze first. These designs necessitate the free use of mechanical chills, which, setting up undue stresses through cooling strain, are a common cause of premature cracking in service.

Conclusion.—In concluding, the author wishes to state that this Paper has dealt only with one phase of the cylinder problem. It has essayed to show that successful practice of the art of cylinder manufacture can only be expected when the scientific principles involved are understood, when there is the right combination of art and science in manufacture, and when the foundryman and engineer understand and recognise each other's difficulties.

Pulverised Coal and the Ash Question.

FROM A CORRESPONDENT.

One of the objections that has often been raised in this country against pulverised fuel firing for steam boilers is that a large part of the ash is blown out of the top of the chimney. It has been stated that in some cases as much as 70 to 80 per cent. of the ash is discharged in this way, and that consequently pulverised fuel firing on an extended scale would be impossible in or near a large town. It has also been urged as a further objection to pulverised fuel firing that a large part of the ash becomes molten in the furnace, giving the trouble of "slagging"; further, that difficulty arises from the fact that ash is deposited all over the boiler, superheater, and economiser tubes, as well as in the flues. It is obvious, however, that as hardly anyone in Great Britain has had any experience of pulverised coal, such objections are merely theoretical.

In a very detailed Paper on pulverised fuel and the ash question, read recently in Canada before the Ontario Section of the American Society of Mechanical Engineers, MR. H. D. SAVAGE gave some rather striking facts on the subject. He stated that at the very large Lakeside plant of 40,000 kw. the ash had never given the slightest trouble, and he further claimed that statements to the effect that 70 to 80 per cent. was discharged from the plant had no foundation in fact.

There are only two places where any actual determination of the ash distribution has been carried out—the original Oneida St. plant and the new Lakeside plant of the Milwaukee Electric Power and Light Company. The former was the original "Lopulco" pulverised fuel installation, from the experience of which Lakeside was designed and erected. The U.S. Bureau of Mines carried out on this plant a series of trials on the ash question, and the mean of 30 tests was that 29.5 per cent. of the ash was discharged, *i.e.*, was not accounted for. The coal used contained 11 per cent. of ash, so that the equivalent was 3 per cent. of the weight of the coal emitted as ash from the chimney. Mechanical stoking to-day is giving about the same figure, except that in this case the particles of grit and dirt are of large size and fall in the immediate neighbourhood, whereas in the case of pulverised coal they are so excessively minute (65 per cent. of the original coal being equivalent to passing through a 200-mesh screen, that is, 40,000 holes per sq. in.) that they would remain indefinitely floating in the air if they were not washed down by the rain. Savage also gives the actual figures for a very large super-power station of 10 boilers of 15,000 sq. ft. heating surface (150,000 lbs. of water from and at 212 deg. Fah. evaporated per boiler per hour). This is equal to 49 tons of coal per hour on the plant, or 1,176 tons of coal per 24 hours, which at 10 per cent. ash gives 117.6 tons of ash. Assuming 29 per cent. of the ash is discharged from the chimney, this is 34 tons of fine ash per 24 hours. If all this ash were deposited even within a radius of 1½ miles from the plant (7 sq. miles), which is quite impossible, it would only be equal to 0.00031 lb. of ash per sq. ft. per 24 hours, or 1.8 ounces per annum. Finally, the author claimed that the whole question of ash troubles was simply nonsense, as no such difficulties existed or ever had existed, whilst pulverised coal was actually much superior in respect of black smoke and solid material discharged from the chimney. The figures at Lakeside (a modern plant specially adapted for pulverised fuel), as given by Mr. David Brownlie in his recent Paper before the Institution of Electrical Engineers, are 12 to 25 per cent. of the ash blown out of the chimney, 25 to 30 per cent. deposited between the furnace and the chimney base, and 25 to 50 per cent. in the bottom of the furnace, where slagging would be caused if it were not for the "Lopulco" water screens.

In this connection it has recently been announced that the Union d'Electricité, in the new extensions to their plant at Gennevilliers, Paris (the largest and most modern power station in Europe, recently completed for 200,000 kw., and now to be extended to 300,000 kw.), have decided to adopt pulverised coal for firing "Ladd" boilers made by the Delaunay-Belleville firm.

Obituary.

MR. J. SUMMERS, who was well known on the North-East Coast as a marine engineer, died recently at the age of 81.

MR. D. MCKEE, managing director of Maden & McKee, Limited, iron, metal, and machinery merchants, died on February 18.

MR. G. LAYTON, managing director of the Cosmos Lamp Works, Limited, at Brimsdown, of the Metropolitan-Vickers Electrical Company, Limited, died recently.

MR. E. COOKSON, who died at his home at Stourbridge, aged 57 years, was a well-known authority on foundry work. He had been associated with M. & W. Grazebrook, ironmasters, Netherton, for 37 years. When the private firm was formed into a company in 1914 Mr. Cookson became one of the directors, and remained so until his death. He was also a director of Charles Akrill & Company, Limited, ironfounders, West Bromwich, and of Stourbridge Refractories, Limited.

SIR ROBERT ROPNER, BART., the well-known North of England shipowner and shipbuilder, who founded the firms of Messrs. R. Ropner & Company, shipowners, West Hartlepool, and the Ropner Shipbuilding & Repairing Company, at Stockton, died at Preston Hall, Stockton-on-Tees, last week. For ten years Sir Robert represented Stockton in Parliament, and previously he contested the Cleveland division of Yorkshire twice. He had reached the age of 85. Colonel John Henry Ropner, who is 64 years of age, succeeds to the title.

Metals for Domestic Hollow-Ware.—A lecture was given at Bilston before the Birmingham Metallurgical Society on Thursday, February 21, by CAPTAIN N. MARTIN, B.Sc., on the possibilities of sheet steel for a wide variety of purposes, especially on the ground of cheapness and ductility. He anticipated that the future of hollow-ware rested chiefly with sheet steel, nickel and stainless iron. In the course of a discussion it was stated that while sheet steel cost roughly about £17 per ton, aluminium was about four times that price, cast iron and stainless steel four and a-half times, brass seven times, copper seven and a-quarter times, and nickel nineteen times.

XUM

Institute of British Foundrymen.

SHEFFIELD AND EAST MIDLAND BRANCHES.

Foundrymen's Praise.

An instructive and enjoyable visit of the Institute of British Foundrymen (Sheffield and East Midlands Branches) took place to the Broad Oaks Ironworks of Messrs. Markham & Company, Limited, Chesterfield, on February 23.

About 150 were present, and much was seen to demonstrate the remarkable progress which is being made by this old-established firm. The Sheffield Branch visitors included Mr. John Shaw (President) and Mr. W. A. MacDonald (Secretary), and Mr. S. H. Russell (Leicester) was present as the President of the East Midlands Branch.

The visitors were shown round by Councillor C. J. Mawhood (managing director), Mr. Read (works manager), and Mr. G. Edginton (foundry manager).

First, the colliery engineering department was visited, and considerable interest was evinced in a set of winding engines in course of construction for the new Firbeck Collieries. Headgear and drums were also inspected, together with underground haulage engines—a speciality of the firm to take the place of ponies—which were seen in operation under compressed air. No little interest was manifested in a tunnelling shield of the type which the firm are constructing for extending the London tube railways. One of these wonderful productions, of the excavator type, was seen at work; it permits of the excavation going on while the trains are running. The tour also included the constructional department, pattern and erecting shops, and the commodious and well-equipped iron and steel foundries.

By the kindness of Messrs. Markham & Company, tea was provided in the works messroom, and a hearty vote of thanks was accorded for the hospitality, on the motion of Mr. Shaw, seconded by Mr. Russell, Councillor Mawhood replying.

Afterwards, under the Sheffield President's chairmanship, Mr. George Edginton (foundry manager for Messrs. Markham & Company) gave the following Paper on "Oil Sand Cores":—

Oil Sand Cores.

As the most practical part of this Paper has been demonstrated previous to its presentation, it is proposed to outline a few of the methods of making cores and the preparation of sand, of sufficient scope to raise discussion and criticism. There is much to learn, as only the fringe of what can be done by the use of sea sand when bonded with oil for making cores has been touched.

Preparation of Core Boxes.

Close co-operation must exist between the foundry and the pattern shop, as success depends very largely on this being carried out. Core boxes must be made, so that pieces can be taken away without disturbing the sand while in its green state. In many cases only half-boxes are made, as this provides a flat surface for turning out on to plates. When dry, the two halves are then gummed together. This sand readily lends itself to this method; but this is not always considered necessary, as the joints are usually so good they do not show when cast. Where there are overhanging pieces, over brackets and ribs, etc., the brackets or ribs are made in sand instead of timber. That implies the patternmaker gives the coremaker a core box, from which he makes the rib or bracket in sand. These remain in until the core is baked, and are then easily removed. Such pieces serve for quite a number of cores. They save irons, and the method is very much quicker, for when the core is once dry it is very strong and will not warp. Core boxes are better when varnished, as this prevents any sticking of sand. The core boxes last much longer with this method, as they are not damaged by the rammers and rapping.

Preparation of Sand.

The preparation of sand is very simple; any foundry labourer can do it after being once shown. The sand is brought in from the storage, spread out on plates, the required quantity of oil added to it, turned over once, then passed through a machine of the revolving type, which deposits it in the core shop ready for use. In the winter, when the sand is carrying more moisture, due to weather conditions, a quantity of sand is dried each day for use the following day, as it is not wise to try to work it with too much moisture. All the old sand which gathered up in the cleaning shop is used over again. For general work and the biggest cores the proportion of sand to oil is 40 parts of sand to 1 part of oil, by volume. For steel castings and more delicate cores, about 25 to 1 is used.

Making of Cores.

When making large cores they are handled as little as possible when in a green state. On core carriages at Broad Oaks foundry, plates with machined surfaces are used. The core box is placed on one of these, and the core made; then the box is removed, and so on, until the carriage is full. This is a distinct advantage with oil sand, as the plates are warm and the cores quickly stiffen up before the carriage is moved, and therefore less liable to breakages. Also, it is not necessary to use all oil sand; if the box is lined with about 1½ in. of sand, then filled up with cinders and old shop sand, considerable material can be saved.

Vent holes must be left in the top of cores, to allow the steam to escape. This is very important, as oil cores become very hard on top soon after being stoved, which traps the steam inside, and does not allow of the core being properly baked. This is not necessary in smaller cores, and no vents are used for a number of jobs. Core-iron making is reduced to a minimum, and a set of cores is often made in the time previously taken to make core irons. In some cases, however, old feeding rods, and lifters with a hook of bowed iron, must be used. For quantity production jobs, a set of irons is made, but the sand shakes away so easily, the irons can be used a number of times without fear of breakages. Therefore the saving in time, in a large foundry like the Broad Oaks, is very considerable when spread over a year. Additionally, it has been demonstrated how much quicker these cores can be made than by the older method, as no ramming is required. The sand is pushed in box with the hands, or pressed down with the feet in the bigger cores. This results in less damage to the boxes by the rammer, and, what is still more important, they are not distorted, which in many cases can involve hours of rubbing for the moulder before obtaining the required thickness and shape.

Another useful method of applying this sand is to make the cope portion of a mould instead of using a box part. These can be made very quickly, and give a much more accurate casting. In jobs when the metal is 2 in. thick or more, it is important that the blacking should be used rather thicker, and rubbed on well with the hand, as the oil prevents the blacking getting into the face of the sand.

Drying Conditions.

The best temperature for drying oil-sand cores is about 350 to 400 deg. F. (175 to 205 deg. C.), and the time taken varies according to the size of core. No special stoves have been provided, the practice being to keep the smaller cores farther away from the fire, and where formerly ten hours was taken, from three to four hours is now occupied, which results in the saving of fuel on three core stoves which is obviously very considerable.

Oil sand cores, when baked properly, do not scab. They are fool-proof. Most foundrymen know the disappointment and setbacks due to a core being broken after a large job is partly assembled. This is quite impossible with these cores, with normal treatment. Also, when cast, the oil bond burns itself out, allowing the casting much more freedom for contraction than formerly, and cracked castings are very rare. This is important, especially in steel castings. The Broad Oaks foundry is doing very little bracketing in

their cores, and it is very rarely they get a pull. For a certain type of core, in which no core irons are used, the inside can be filled with several kinds of material, such as a mixture of weak sand and sawdust; then, as the oil bond burns out, it will allow free shrinkage without setting up any strains to pull or crack the castings.

Considerable time is saved in cleaning the castings, the cores being shaken out very easily. The coring of cylinders, block pistons, etc., which were regarded as special jobs, have become quite ordinary to the cleaners.

Conclusion.

Amongst the advantages are:—Pattern-shop costs are reduced, as less timber is used, and boxes last longer; considerable time is saved by eliminating the use of core irons; fuel economies amount to quite 50 per cent.; better cores are made quicker, implying increased output, and the reduction of wasters by less scabbing and blowing from cores; and, lastly, cleaning-shop costs are reduced considerably.

DISCUSSION.

The Paper gave rise to a helpful discussion, in which many members took part, all uniting in expressing agreeable surprise at the striking results they had witnessed in Broad Oaks foundry.

MR. W T. EVANS (Derby) warmly complimented Messrs. Markham upon the success of their efforts in the use of oil sand. Their visit, he said, had proved an education to many of them. They were all delighted to visualise the great success which had rewarded the bold steps adopted in the foundry by the firm.

MR. J. G. ROBINSON (Halifax) admitted that Mr. Edginton had accomplished things in oil sand which he (the speaker) would be afraid to do. Apparently at Broad Oaks they had broken down the prejudice of the coremakers against using oil sand. He was convinced that the use of oil sand saved time in fettling, and that it more than paid for itself. He wondered if Mr. Edginton could give them any definite statistics as to times for drying oil-sand cores. His (Mr. Robinson's) experience was that an average of one hour per inch thickness was sufficient. He would like to know if Mr. Edginton's experience of oil-sand cores for engine moulds was satisfactory. They would all, after what they had seen in Messrs. Markham's foundry, have much more confidence in using oil sand.

MR. J. R. HYDE (Chesterfield) emphasised the remarkable progress exemplified in the firm's foundry. What was being done showed that the younger school of thought was being developed. They had, of course, been familiar with oil-sand cores for the smaller type of casting for many years, but Mr. Edginton had tackled something bigger with good results. He must add his testimony to the revolutionary conditions which they had witnessed that day.

Replying to points raised, Mr. Edginton said his experience was that oil-sand cores were quite safe to use in engine moulds.

Thanks were accorded Mr. Edginton, on the proposition of Commander Jackson (Sheffield), seconded by Mr. W. A. MacDonald (Sheffield), and supported by Mr. Stephenson (Nottingham).

Calendars, etc., Received.

Since publishing our last list we have received the following:—**Messrs. John & Edwin Wright, Limited**, Universe Rope Works, Birmingham, manufacturers of foundry crane steel ropes, etc.—Monthly tear-off wall calendar. **Messrs. Robert Hyde & Son, Limited**, Sheffield and Chesterfield, iron and steel founders. A novelty leather combination card, note and season ticket case. **Messrs. The Yorkshire Testing Works, Limited, St. Peter's Close, Sheffield.**—A monthly tear-off wall-calendar which is interleaved with British Standard Specifications for ferrous material—a useful innovation.

The Newcastle Conference.

The progress which the Reception Committee of the Newcastle Branch has made can be judged by the list of subscriptions received or promised. Already of the £500 asked for, well over £300 has been found. Captain E. Wood, the chairman, Mr. Colin Gresty, the honorary secretary, and Mr. H. F. Parsons, the honorary treasurer, are to be congratulated on their initial success.

The list of subscriptions now is:—

	£	s	d.
The North Eastern Marine Eng. Co., Ltd., Wallsend and Sunderland	30	0	0
The Wallsend Slipway & Engineering Company, Limited	30	0	0
R. & W. Hawthorn, Leslie & Company, Limited	25	0	0
C. W. Taylor & Son, Limited	25	0	0
Smith, Patterson & Company, Limited	25	0	0
Smith & Company (South Shields), Limited	20	0	0
The Consett Iron Company, Limited	15	0	0
The Birtley Iron Company	10	10	0
Newalls Insulation Company, Limited	10	0	0
Hy. Watson & Sons, Limited	5	5	0
Mr. R. O. Patterson	5	5	0
Mr. James Smith	5	5	0
Mr. Summers Hunter, C.B.E., J.P.	5	5	0
J Stone & Company, Limited, London	5	5	0
The Fordath Engineering Company, Limited, West Bromwich	5	5	0
THE FOUNDRY TRADE JOURNAL	5	5	0
G. & J. Weir, Limited	5	0	0
Clarke, Chapman & Company, Limited	5	0	0
John Spencer & Sons, Limited	5	0	0
A. Leith & Company	5	0	0
The Darlington Forge, Limited	5	0	0
Lawson Walton & Company, Limited	5	0	0
Mr. Theodore Peart	5	0	0

Messrs. Urwin & Company, £3 3s.; Messrs. Younger & Gallon, Dunston, £3 3s.

Mr. E. Wood, £2 2s.; Mr. H. J. Young, £2 2s.; Mr. H. F. Parsons, £2 2s.; Mr. H. K. Denton, £2 2s.; Lieut.-Col. H. Gordon-Luhrs, C.M.G., £2 2s.; Mr. H. Hunter, £2 2s.; Mr. J. M. Weir, £2 2s.; Mr. M. E. Gallon, £2 2s.; Mr. V. C. Faulkner (London), £2 2s.; Messrs. F. Graham & Company, £2 2s.; Messrs. Rimer Bros., £2 2s.; Messrs. Richardson Bros., £2 2s.; Messrs. T. Wilkinson & Company, Middlesborough, £2 2s.

Mr. R. H. Smith, £1 1s.; Messrs. I. and I. Walker, Rotherham, £1 1s.; Mr. Colin Gresty, £1 1s.; Mr. F. Adam, £1 1s.; Mr. J. W. Eckford, £1 1s.; Mr. A. Logan, £1 1s.; Mr. J. Neill, £1 1s.; Mr. S. Dickinson, £1 1s.; Mr. J. W. Frier, £1.

Mr. W. A. Corbett, 10s. 6d.; Mr. A. H. Tait, 10s. 6d.; Mr. H. C. Jay, 10s.; Mr. Frank H. Parsons, 10s.; Miss M. D. Pittuck, 5s.—Total, £307 11s.

Further subscriptions should be sent to the Hon. Treasurer, Mr. H. F. Parsons, 8, Heaton Park View, Heaton, and will be acknowledged through the Press.

Correspondence.

[We accept no responsibility for the statements made or the opinions expressed by our correspondents.]

New Grinding and Fettling Regulations.

To the Editor of THE FOUNDRY TRADE JOURNAL.

SIR,—Under the provisions of the Factory Acts any objections to the making of these regulations has to be lodged with the Home Office within forty days of the date of the issue of the draft, viz., February 8. In view of the numerous heavy obligations imposed on employers, my Association proposes to lodge an objection against certain parts of the draft order. If any of the National or District Organisations concerned are taking a similar course I shall be glad if they will communicate with me in order that a joint or common action may be taken so far as circumstances allow.

Yours, etc.,

PERCY RUSSELL,
Secretary.

The Leicester and District Ironfounders Employers' Association.
8, New Street, Leicester.

The Refractories Association.

Mr. Frank Russell, the Chairman of the General Refractories Association, has been elected President of the Refractories Association, and will take the chair at the Annual Dinner to be held in Sheffield on March 7.

Comparative Investigation of Basic and Acid Steels.

In a Paper published in a recent issue of "Stahl und Eisen," Dr. Fritz Schmitz, of Düsseldorf, suggests for comparing basic and acid steels a method which may afford interesting results. Some investigators in the past have come to the conclusion that acid steel, with the same carbon content, has a slightly higher mechanical strength than basic steel, while others claim that the difference in mechanical properties between the two kinds of steel of the same approximate composition is practically negligible. Recently, Daeves and Goerens have pointed out the special advantages of comparative investigations carried out on as large a number of specimens as possible, and Dr. Schmitz followed the same method in his own investigations.

He used 200 basic- and 200 acid-steel specimens all of them samples taken during pouring. They were cast into small ingots and forged under a steam hammer into test bars for chemical and tensile tests. After forging the tensile test pieces were annealed for about two hours at 720 to 750 deg. C., the temperature and amount of forging being practically the same for all the specimens. The test pieces for chemical analysis were selected from the furnace charge book indiscriminately, but making sure that the contents were within 0.45 and 0.54 per cent. carbon, 0.85 and 1.15 per cent. manganese, 0.25 and 0.50 per cent. silicon, less than 0.07 per cent. phosphorus, and less than 0.06 per cent. sulphur. For every 0.01 per cent. of carbon between the limits 0.45 and 0.54 per cent., twenty samples were selected, so that altogether for both the acid and basic steels 10 × 20 = 200 specimens were used. The tensile tests were made to determine yield point, ultimate strength, elongation, and reduction of area. The diameter of the test bars was 20 mm. (about ¾ in.), with a length of 100 mm. (say 4 in.) between pop marks.

In grouping the results of the chemical and tensile tests in the case of both makes of steel, the average chemical composition and tensile strength corresponding to a given carbon content were tabulated. In Tables I and II, therefore, each value represents the mean of 20 single values of similar carbon content.

The tables show that, with increasing carbon content, there is an increase in the yield point and tensile strength, but a decrease in the elongation and reduction of area. If a mean is struck from the ten mean values of Tables I and II, *i.e.*, the mean for all 200 specimens of each make of steel, it will be found that the yield point of the acid specimens was on the average 0.36 tons per sq. in., and the tensile strength 0.43 tons per sq. in. higher than the corresponding average values for the basic samples, while elongation and reduction in area were 0.34 per cent. and 4.51 per cent. lower respectively.

The next point to settle was how far these differences were due to differences in the mean values of the chemical composition. For this purpose the figures for the 200 steel specimens were re-arranged and tabulated so that in addition to the carbon content being the same in the acid and basic samples, the manganese contents were also approximately the same. A tolerance of not more than 0.02 per cent. was permitted in the manganese content in selecting the pairs. In this way it was possible, for example, to pick out from the steels with 0.45 per cent. of carbon ten pairs (one acid to one basic) with practically the same manganese content. Altogether some 96 pairs could be picked out in which the carbon and manganese contents were practically the same.

The grand averages of these 96 pairs, curiously enough, also gave the same mean between basic and acid for the silicon content. They are given in Table III, and show that the differences in yield point, tensile strength and elongation were much less than they were when comparing the means of the 200 basic and acid samples in Tables I and II. It is, however, surprising to note that the reduction in area is still much higher in the basic than in the acid specimens.

Finally, in order to exclude the effects of varying phosphorus content, 18 pairs of samples were selected having the same percentages—or approximately so—of carbon, manganese, silicon and

Table I.—*Mean Values of 20 Basic Steel Samples.*

Chemical composition.					Tensile tests.			
C	Mn	Si	P	S	Yield point.	Tensile strength	Elongation	Reduction of area
Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Tons/sq. in.	Tons/sq. in.	Per cent.	Per cent.
0.45	0.95	0.26	0.054	0.038	24.1	43.4	17.8	44.1
0.46	0.90	0.29	0.043	0.034	24.1	43.4	17.8	44.2
0.47	0.89	0.26	0.045	0.036	23.6	43.2	17.8	42.9
0.48	0.97	0.28	0.041	0.034	24.0	44.2	17.2	41.5
0.49	1.00	0.28	0.032	0.031	24.1	45.8	16.6	41.8
0.50	1.01	0.28	0.022	0.030	24.6	46.7	16.4	38.6
0.51	0.99	0.29	0.036	0.034	24.3	46.7	16.4	39.2
0.52	1.02	0.28	0.030	0.033	25.5	47.6	16.1	38.5
0.53	0.98	0.30	0.031	0.030	24.6	46.9	16.3	37.5
0.54	1.01	0.28	0.034	0.034	25.3	47.5	15.0	37.5
			Means	of all 200 samples.				
0.495	0.972	0.28	0.0368	0.0334	24.42	45.54	16.83	40.58

Table II.—*Mean Values of 20 Acid Steel Samples.*

Chemical composition.					Tensile tests.			
C	Mn	Si	P	S	Yield point.	Tensile strength.	Elongation	Reduction of area.
Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Tons/sq.in.	Tons/sq. in	Per cent.	Per cent.
0.45	1.03	0.30	0.057	0.047	23.6	43.6	17.5	38.4
0.46	1.04	0.28	0.054	0.052	24.1	43.6	17.2	37.6
0.47	1.01	0.28	0.057	0.046	24.1	44.3	17.1	38.7
0.48	1.08	0.28	0.054	0.048	25.0	45.4	16.8	38.6
0.49	1.04	0.27	0.058	0.048	24.8	45.6	16.7	38.0
0.50	1.03	0.29	0.061	0.046	24.9	46.6	15.9	36.4
0.51	1.03	0.30	0.061	0.043	25.6	47.1	16.2	35.5
0.52	1.05	0.27	0.058	0.049	24.9	46.7	16.4	32.9
0.53	1.09	0.29	0.057	0.045	25.3	48.1	15.5	31.9
0.54	1.06	0.29	0.056	0.052	25.5	48.7	15.6	32.7
			Means	of all 200 samples.				
0.495	1.045	0.285	0.0573	0.0476	24.78	45.97	16.49	36.07

phosphorus; see Table IV. These pairs were taken from the 96 pairs in Table III. As will be seen, the differences in the averages for basic and acid steels are extremely small, except in the case of reduction of area, the difference in which was over 4 per cent., as in Table III.

To summarise the results: In the averages of the 200 basic and acid steels investigated, there is no practical difference in the tensile strength values, with the exception of the reduction of area, provided, of course, that steels are selected of approximately the same chemical composition. The most that can be said is that the tensile-strength figures in the case of acid steels are a fraction of a ton per sq. in. higher. A remarkable difference between the acid and basic steels, however, is the much lower reduction of area of the acid steels. The reduction in area of the test

would behave somewhat differently from basic steels under these conditions.

In comparing basic and acid steels of the same composition the difference in the behaviour of the two kinds of steel has not yet been properly established, and it would be well to take the average chemical composition also into account. Table III of the 96 pairs of acid and basic steels shows that, although the carbon, manganese and silicon contents were about the same, the acid steels had much higher average phosphorus and sulphur contents than the basic steels. This fact demonstrates that it is possible with the basic process, and even using charges high in phosphorus and sulphur to produce a steel which will give lower average values for phosphorus and sulphur than the average steel produced in the acid furnace from a charge specially selected for purity.

TABLE III.—*Mean Values of 96 Pairs of Basic and Acid Steels with the same C, Mn, and Si Contents.*

Kind of steel.	Chemical composition.					Tensile tests.			
	C	Mn	Si	P	S	Yield point.	Tensile strength	Elongation.	Reduction of area.
	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Tons/sq. in.	Tons/sq. in.	Per cent.	Per cent.
Basic ..	0.504	1.011	0.286	0.036	0.033	24.71	46.04	16.67	39.96
Acid ..	0.504	1.012	0.282	0.057	0.048	24.79	46.13	16.39	35.92
Difference	0	—0.001	+0.004	—0.021	—0.015	—0.08	—0.09	+0.28	+4.04

specimens which had not been given sufficient consideration in previous investigations is closely related to the appearance of the fracture and the mean size of grains of polished and etched specimens, as well as the toughness of the material. Experience shows that the fracture of acid-steel specimens shows a slightly coarser grain than the fracture of basic steels of the same chemical composition and subjected to the same treatment. The coarser grain of the acid specimens as compared with the basic steels is therefore not due to overheating or re-crystallisation, but is peculiar to acid steel. It is a recognised fact, too, that a coarser fracture is concomitant with a lower value for reduction of area. There is also a certain numerical relation between the contraction (reduction of area) of tensile test pieces and the toughness of the material. For basic carbon steels of low manganese content these relations have been plotted in a diagram in another Paper by the present writer, and also for forged, re-heated and

TABLE IV.—*Mean Values of 18 Pairs of Basic and Acid Steel Samples with the same C, Mn, Si and P.*

Kind of steel.	Chemical composition.					Tensile tests.			
	C	Mn	Si	P	S	Yield point.	Tensile strength	Elongation.	Reduction of area.
	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Tons/sq. in.	Tons/sq. in.	Per cent.	Per cent.
Basic ..	0.485	0.989	0.277	0.051	0.037	24.83	45.29	16.89	41.48
Acid ..	0.485	0.991	0.285	0.054	0.050	24.77	45.44	16.90	37.35
Difference..	0	—0.002	—0.008	0.003	—0.013	+0.06	— 0.15	—0.01	+4.13

treated steels. This difference in reduction of area, expressed in terms of "specific notch tenacity," gives 41.48 × 0.2 = 8.3 metre-kilos. per sq. cm. for the basic steels, and a corresponding value of 37.35 × 0.2 = 7.5 metre-kilos. per sq. cm. for the acid steel. It is very probable, therefore, that, using a notch test-bar of 160 × (30 × 30) mm. and an impact testing machine with a drop of 75 metre-kilos., the notch tenacity of the acid steels is only 9-10ths of that of the basic steel of the same chemical composition.

The acid steel, being less tough than the basic, may explain the tendency of the former to develop strain cracks in castings on cooling. The writer thinks it may be possible to overcome this tendency by alterations in design and special modifications in the foundry practice. It would be desirable to compare the notch-tenacity, repeated impact strength and resistance to wear of steels, both acid and basic, on a large number of specimens as has been done for the tensile strength. Observations seem to indicate that acid steels

Catalogues Received.

Cast-Iron Pipes.—The monthly stock list for March, issued by the Staveley Coal and Iron Company, Limited, of Chesterfield, is now available.

Castings.—Messrs. John Harper, of Albion Works, Willenhall, have sent us their new brochure, No. A 24. This catalogue states the tests to be expected from their grey iron, semi-steel and malleable cast iron. It is well illustrated with pictures of typical castings, including art casting, resistance grids, and other electrical and domestic castings.

Foundry Plant and Equipment.—Probably the new edition of the catalogue of Messrs. J. W. Jackman & Company, Limited, of Vulcan Works, Blackfriars Road, Manchester, is the most comprehensive foundry catalogue ever published. It is a beautifully produced work of more than 300 well illustrated art pages. It is divided into 11 sections, the last of which bearing the caption, "Useful Tables for Foundrymen," is adequately described. The arrangement has been to start with requisites and sundries and follow on with sections dealing with melting equipment, metal recovery machinery; sand preparing plant; moulding machines; core shop equipment; fettling shop plant; air compressors and receivers; transport equipment, and testing machines. For foreign and colonial buyers a convenient coding system has been incorporated. We understand this catalogue is now available for distribution to the trade, and foundrymen who are not in possession of a copy would do well to secure a copy before the edition is exhausted.

Patent Specifications.

211,186. E. A. ROPER. Foundry cupolas.

211,210. W. B. HAMILTON and T. A. EVANS. Manufacture of iron and steel alloys.

211,417. W. D. MOORE. Method and apparatus for facing foundry moulds.

XUM

Company News.

Direct File and Tool Company, Limited, 10, King Street West, Manchester.—Capital £100. Director: A. Bowns.

R. and W. Hawthorn, Leslie & Company, Limited.—Interim ordinary dividend, 4 per cent. per annum, less tax.

Rossanglin Engineers, Limited, Bradford Road, Bailiff Bridge, Yorks.—Capital £1,000 in £1 shares. Directors: J. W. Firth, P. Firth, and J. Rigg.

Engineers and Millwrights, Limited, 311, Gray's Inn Road, London, W.C.—Capital £1,000. Permanent joint managing directors: W. A. Tunstill and J. Page.

English Cable Supplies, Limited, 12, Hackins Hey, Liverpool.—Capital £500 in £1 shares. Directors: J. Pendleton and Mrs. Mary C. Pendleton.

Gandy Belt Manufacturing Company, Limited.—Final dividend, 2s. 6d. per share on ordinary, free of tax, making 4s. per share (20 per cent.) for year.

Gillett & Johnston, Limited, West Street, Finsbury Circus, London, E.C.—Capital £20,000 in £1 shares. Iron founders, etc. Directors: F. L. Spicer and A. J. Tempest.

G.W., Limited.—Capital £5,000 in £1 shares, to acquire an invention, viz., a combined plug and switch electrical safety box. Electrical and general engineers, etc.

Rees Mace Manufacturing Company, Limited, 50, Pall Mall, London, S.W.1.—Capital £1,000 in £1 shares. Engineers, etc. Directors: L. H. Pell and M. R. Cahill.

Reginald H. Pearson, Limited, 10, Old Burlington Street, London, W.1.—Capital £6,000 in £1 shares. Aerial ropeway and consulting engineers. Director: R. H. Pearson.

James Rogerson & Company, Limited, Freedom Works, John Street, Sheffield.—Capital £7,000 in £1 shares. Steel makers and converters, etc. J. Rogerson is permanent managing director.

Scottish Iron & Steel Company, Limited.—Dividend on participating preference, 3 per cent. actual for half-year, making 6 per cent. for year; dividend on ordinary shares, 6 per cent. for year, both less tax.

North British Locomotive Company, Limited.—Dividend, 5 per cent. for year on ordinary shares, free of tax; to meet adverse trading balance £50,000 taken from reserve and £15,838 carried forward.

Yorkshire Engine Company, Limited.—Profit, £7,184; brought forward, £24,176; reserve, £10,000; preference dividend, £1,153; ordinary dividend, 5 per cent., free of tax, £2,640; carried forward, £27,567.

Alfred Postlethwaite, Limited, Staffordshire Works, Bell Street, West Bromwich.—Capital £5,000 in £1 shares. Brass factors, etc. Directors: A. J. Postlethwaite, Mrs. H. M. Postlethwaite and W. Johnson.

National Gas Engine Company, Limited.—Net profit, £19,861; brought forward, £10,599; final dividend on preference shares, 5 per cent. per annum, less tax; carried forward, £18,449. No dividend on ordinary shares.

General Hydraulic Power Company, Limited.—Gross receipts, £234,545; depreciation, £32,000; brought forward, £20,624; balance, £52,349; dividend, 4 per cent. on ordinary, making 5 per cent. for year; carry forward, £9,849.

Coutinho, Caro & Company (London), Limited, 6, Lloyd's Avenue, London, E.C.3.—Capital £25,000 in £1 shares. Iron and steel merchants, etc. Directors: F. Coutinho, R. Caro, W. J. Carter, A. E. Avery and H. Brunst.

Staffordshire Stainless Iron Company, Limited, Baldwin House, Bilston, Staffs.—Directors: Col. O. H. Stanley, R. S. Guines (director, Falkirk Iron Company, Limited), G. H. Sankey (director, John Lysaght, Limited), N. Martin and W. S. Gifford.

Bruce Peebles & Company, Limited.—Dividend on preference shares, 7½ per cent. per annum for half-year; further dividend, 2½ per cent. per annum for year; dividend on ordinary, 10 per cent. per annum, bonus, 5 per cent., for year, less tax.

Vickers, Limited.—Final dividends for half-year ended December 31, 1923: 2½ per cent. on preferred 5 per cent. stock (less tax); 2½ per cent. on 5 per cent. preference shares (less tax); and 2½ per cent. on cumulative preference shares (free of tax).

Millom & Askam Hematite Iron Company, Limited.—Accounts for two years: Brought forward from 1921, £29,707; debenture interest and redemption for 1922, £9,303; balance, £7,203; debenture interest and redemption for 1923, £9,303; balance credit profit and loss account at September 30, 1923, £15,563.

Hoffmann Manufacturing Company, Limited.—Profit, £117,729; brought forward, £17,850; balance, after deducting debenture and loan interest, reserve for income tax, general reserve (£10,000), and preference dividend, £69,933; ordinary dividend, 6 per cent., free of tax, £15,000; carried forward, £41,371.

Alexander, Fergusson & Company, Limited.—Profit, £18,556; brought forward, £7,259; depreciation, £4,000; reserve, £3,000; dividend on preference shares for year, £2,690; dividend on A and B ordinary shares for year, 12½ per cent. per annum, £6,781; bonus dividend on A and B ordinary shares, 5 per cent. per annum, £2,713; carried forward, £6,631.

Charles Clifford & Son, Limited.—Net profit, £13,727; brought forward, £16,637; total, £30,364; six months' dividend on preference shares to December 31, 1923, 6 per cent. per annum (less tax); six months' dividend on ordinary shares to December 31, 10 per cent. per annum, together with bonus of 5 per cent. (both free of tax); carry forward, £21,134.

Trade Talk.

BAXTER, FELL & COMPANY, iron and steel merchants, have removed from 22, Great Tower Street, to 36, Leadenhall Street, London, E.C.3.

AT THE SHEFFIELD METALLURGICAL CLUB, on February 26, Mr. J. H. G. Monypenny, Assoc. Met., gave a lecture entitled "Some Notes on the Metallurgical Microscope."

A LICENCE under the Non-Ferrous Metal Industry Act, 1918, has been granted to Bentley, Brown & Company, 59, Gracechurch Street, London, E.C.3.

THE WHITEHEAD IRON & STEEL COMPANY, LIMITED, are now proceeding with the second stage of the development of their Courtybella works, Newport.

JOSEPH KAYE & SONS, LIMITED, Lock Works, Leeds, are supplying the Director of Army Contracts with 2,400 of their patent seamless serrated steel oilfeeders.

MR. H. L. E. WORKMAN, Lancashire and Yorkshire representative for the London Aluminium Company, Limited, of Birmingham, has removed to 28, Queen's Road, Southport.

IN regard to the erection of a new foundry at East Ham, London, E., Mr. C. Binks, brassfounder, Endine Place, Limehouse, London, E.14, states that the contract will probably be placed and the work commenced this month.

THE NEW SOUTH WALES GOVERNMENT has now accepted the tender of Dorman, Long & Company, Limited, of Middlesbrough, for the construction of the North Shore Bridge, linking up the North Shore with the city side of the harbour. The figure in the tender is £4,217,721. We announced in our last issue that the tender has been recommended for acceptance.

AT A MEETING of the Birmingham and Midland Section of the Society of Chemical Industry, on February 21, a paper on "A New Determination of the Specific Gravity of Solutions of Ammonia" was read by Mr. J. Price (Bilston), who collaborated with Mr. C. S. L. Hawkins (Birmingham) in the preparation of data for the paper. Dr. A. C. Monkhouse (of the Fuel Department, Leeds University) addressed the meeting on "The Nitrogen of Coal and Ammonia Recovery."

THE INTERNATIONAL CONSTRUCTION COMPANY, LIMITED, of 56, Kingsway, London, W.C.2, have recently received an order from the London, Midland & Scottish Railway, for their Crewe Steel Works, for six Morgan gas machines with building, coal and ash handling plant and gas piping, which plant will replace a large number of existing producers. Further orders received by the International Construction Company during the last two months for Morgan gas machines are:—Two for the Grovesend Steel & Tinplate Company, Limited, with accessories, for their Dyffryn Steel Works, Morriston, making their third repeat order; two for W. Gilbertson & Company, Limited, Pontardawe Steel and Tinplate Works, near Swansea, including building, gas piping, coal and ash handling plant. The company have also received large orders for furnaces and rolling mills for export.

SPEAKING at the annual banquet of the Rugby Chamber of Commerce, Sir Arnold Gridley, of the English Electric Company, Limited, referred to recent developments in the local engineering industry, which, he said, he hoped would bring additional fame to Rugby. The B.T.H. Company, he said, were engaged in doing two things which were entirely new in the history of the engineering world. They were building, for the first big railway electrification scheme which was being carried out in South Africa entirely new and novel sub-station plant and equipment, which was to operate at the highest pressure yet tried. These sub-stations were to be run automatically, a thing which he believed had never yet been done on any British or Colonial railway system. They were also responsible for the first Diesel electrically operated ship, which had proved to be a great success. So far as the English Electric Company were concerned, they were also engaged in doing something which is entirely new for this country. They were building at the moment five of the largest water turbines which have ever been constructed in the history of engineering—i.e., of 30,000 horse-power capacity. This was the beginning of a new industry for Rugby, which he hoped would grow and expand and find work for a large number of employés.

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Pit Type and Portable Combination Shockless Jar Ramming Power Roll-over and Pattern Drawing Machines; Power Squeezing and Jar Squeezing Machines; Shockless Jarring Machines, etc., etc.

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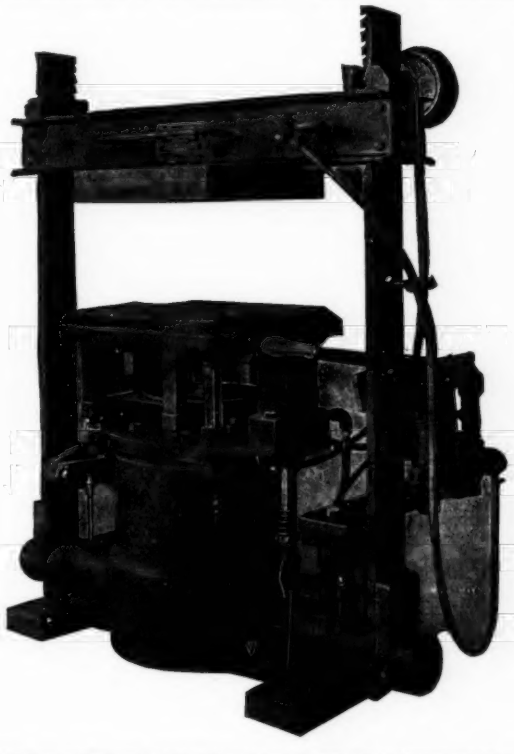

Uniformity in size of Castings produced.

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Minimum Percentage of Wasters.

The above illustrates the TABOR POWER SQUEEZING "SPLIT PATTERN" MOULDING MACHINE, specially suitable for all small patterns which can be split in halves or for flat back Work.

A customer writes—

"The Machines draw perfectly in producing deep castings with the minimum amount of taper, and we are fully satisfied with them, as they are most economical in use and give the maximum production."

Capacities and Dimensions furnished upon application:

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Works: TOTTENHAM, LONDON, N.17.

IRON AND STEEL MARKETS.

Pig-iron.

MIDDLESBROUGH.—The prevailing characteristic at the moment in the Cleveland iron market is an almost complete stagnation in markets now experienced weekly, consequent upon an entire lack of confidence with regard to the future of the industry and a general indisposition of buyers, either for home or export, to enter in further forward commitments. Business is therefore reduced to hand-to-mouth proportions, and even with values gradually weakening stocks continue to accumulate, while should an early recovery be delayed through an extension of labour troubles, production must necessarily undergo considerable restriction. Shipments have also experienced a serious setback, owing largely perhaps to the dockers' strike, the figures for February, calculated at less than 7,000 tons, being ludicrously below the average for the previous month. In well-informed market circles it is regarded as impossible that any revival of demand for pig-iron can materialise until prices are reduced to lower levels than those at present maintained.

In the Tees-side hematite market the position is somewhat similar to that outlined above, but in this case makers are generally adhering to prices, holding the opinion that a reduction would have little effect in stimulating fresh buying at the moment. Hence East Coast mixed numbers are still quoted at 101s., though this would, no doubt, be shaded for any reasonably substantial offer. No. 1 is at premium of 6d. to 1s. per ton. In the North-West Coast area, with little fresh business coming to hand, makers are already contemplating a reduction of output, but for the present there is no change in prices, Bessemer mixed numbers being quoted 115s. delivered at Sheffield, and 120s. at Birmingham.

MANCHESTER.—Current transactions in the local pig-iron market continue disappointing in volume, and very little fresh business is reported. The foundry industry in the district, unfortunately, is still short of work, with a consequent diminution of demand for No. 3 iron, for which the Derbyshire furnaces still quote 95s. f.o.t., while it is worth remarking that the current prices for the three most important kinds of foundry iron, viz., Scotch, Cleveland and Midland, are now practically on a level. This is rather unusual, and suggests that consumption will tend to become more localised than formerly. No doubt much more Scotch iron might be used in the Lancashire district if only some reasonably cheap method of transport could be devised. At present the rate of carriage by rail practically kills a good deal of this trade.

THE MIDLANDS.—At Birmingham market last week buyers of pig-iron evidenced little disposition to open up fresh business, most consumers holding fairly good stocks or having already ordered in sufficient quantities for immediate requirements. The makers of foundry numbers are having more business, and report that some consumers are booking ahead. All grades of No. 3 iron are available for early despatch, but No. 1 Derbyshire and Northants. are still somewhat scarce. Spot lots of furnace coke for early despatch are fetching as much as 30s. per ton at the ovens.

SCOTLAND.—The outlook in the pig-iron industry in this area is regarded with something like apprehension, three furnaces having been blown out last week, while it is reported that several others in West Scotland will shortly close down operations. This curtailment of production, it is hoped, will tend to stop the fall in prices.

Finished Iron.

One of the few exceptions to the general conditions of stagnation in the various sections of the iron and steel markets is that employed in the departments for finished material, in which a steadily increasing demand may be reported. Quite recently some fairly substantial orders have been placed with South Staffordshire makers, while the demand for nut and bolt iron has been on the increase during the last fortnight, and quite good tonnages have been secured by the local mills. The demand for marked bars continues strong, makers of all classes of finished iron finding no difficulty in getting the figures of £14 10s., f.o.t. for marked bars, £12 10s. for crown, and £11 15s. for nut and bolt quality; the last two prices including delivery into consumers' works. The price for Belgian nut and bolt iron is still round about £8 15s. per ton delivered, but delivery cannot be promised with safety under about three months. The difference in price, however, makes it very tempting for the nut and bolt works to go abroad, where delivery is not the deciding factor.

Steel.

Sheffield producers of steel are rather more optimistic with regard to the present outlook of the industry, arguing that the number of open-hearth furnaces now in operation gives convincing evidence that trade activity is at last reviving. As regards semi-products the dock strike does not seem to have helped English manufacturers, and soft billets can still be obtained round about £8, although some makers quote more. Welsh makers, however, are still experiencing keen Continental competition, and are quoting considerably less than this figure. In the tin-plate market there has been, so far, no advance in the official minimum, as had been expected, but makers are holding out for 24s. 6d. basis, I.C., f.o.b., whilst there are a few second-hand parcels about. The Continental sales have been pretty general, but not substantial. Ternes are up.

Scrap.

Reports from the various markets for scrap metal throughout the country evidence continued dulness in most sections, the demand being extremely limited, with prices generally showing a weaker tendency. In the Sheffield district no more than 90s. is offered by the consumers for steel scrap, and in the Welsh district 92s. 6d. per ton. This means, of course, that dealers have to buy steel scrap at from 80s to 85s. per ton, according to the amount of carriage which has to be paid to bring it to the consumer. The market for cast-scrap iron is also quiet and consumers are buying very little. The Lancashire iron founders are still short of work and are not using up much pig-iron.

Metals.

Copper.—During the past week, the market for standard copper has maintained the firmness previously reported, with the tendency of values toward increased strength. This movement may doubtless be attributed to a steady increase in consumption, both at home and abroad, the latest figures available showing that of the total output of American refiners and electro-precipitation plants, 2,248,000,000 lbs. domestic manufacturers absorbed 1,471,000,000 lbs., or 65 per cent., an increase of 574,000,000 lbs. over 1922. This was the largest domestic consumption in the history of the industry with the single exception of 1918, the big war year, when a total of 1,662,000,000 lbs. was used in America, the bulk going into ordnance. Current quotations:—*Cash*: Thursday, £64 15s.; Friday, £66; Monday, £67 7s. 6d.; Tuesday, £67 15s.; Wednesday, £66 17s. 6d. *Three Months*: Thursday, £65 12s. 6d.; Friday, £66 17s. 6d.; Monday, £68 5s.; Tuesday, £68 10s.; Wednesday, £67 12s. 6d.

Tin.—Business in this section of the markets has been on a somewhat less active scale than was marked recently, but with substantial buying support forthcoming values have maintained an upward trend. American advices indicate that consuming industries on that side are operating at around capacity, which certainly seems to foreshadow continued heavy consumption of tin throughout 1924. United States consumers are at the moment, however, apparently a little dubious about supporting the market at the higher levels, particularly as they have covered themselves fairly extensively during recent weeks. Current quotations:—*Cash*: Thursday, £282 5s.; Friday, £288 5s.; Monday, £292 10s.; Tuesday, £289 15s.; Wednesday, £291 10s. *Three Months*: Thursday, £280 5s.; Friday, £284 10s.; Monday, £289; Tuesday, £287 10s.; Wednesday, £289 10s.

Spelter.—Values in the market for this metal indicate increasing strength, due to a steady consumptive demand for industrial purposes. Galvanisers here are generally considered to be very lightly stocked, and with only meagre quantities trickling in from the Continent it appears inevitable that America will be called upon for further supplies. Current quotations:—*Ordinary*: Thursday, £37 8s. 9d.; Friday, £37 15s.; Monday, £36 15s.; Tuesday, £36 7s. 6d.; Wednesday, £36 2s. 6d.

Lead.—The market for soft foreign pig continues active, and during the past week values have moved steadily upward. Up to quite recently German policy has been to sell lead, although not in large quantities, but more recently she has turned an eager buyer. Under the circumstances, with no alteration elsewhere, it is not surprising that the market has been very firm, and although the price is undoubtedly high, there appears to be no uneasiness in regard to the immediate future. Current quotations:—*Soft foreign (prompt)*: Thursday, £37 17s. 6d.; Friday, £37 10s; Monday, £37 15s; Tuesday, £38; Wednesday, £38 7s. 6d.